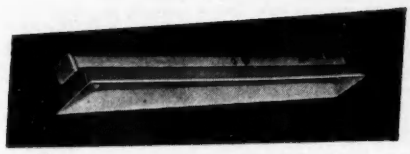
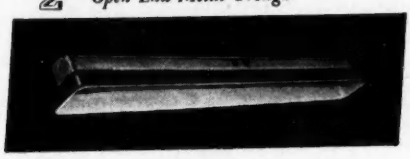
... into one will go



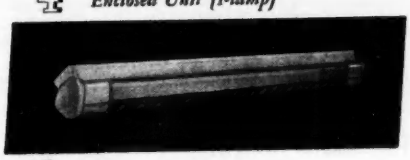
1 *Closed End Metal Trough*

2 *Open End Metal Trough*



3 *Closed End Translucent Trough*

4 *Enclosed Unit (1-lamp)*



5 *Louvre Unit (1-lamp)*

These METROVICK 5-foot fluorescent units all utilise a standard basic channel in which the instant start or switch gear is housed. They are suitable for chain, conduit or direct ceiling mounting. Erection of the ceiling mounting type is greatly simplified by the use of slotted backplates and horseshoe washers which support the unit during fixing. Turret lamp holders permit easy replacement of lamps from either end. METROVICK 5 ft. fluorescent fittings are constructed of sheet steel, bonderised and with a stove enamel finish.

METROVICK 5ft

fluorescent fittings

METROPOLITAN-VICKERS ELECTRICAL CO. LTD.
ST. PAUL'S CORNER, ST. PAUL'S CHURCHYARD, LONDON, E.C.4
Member of the A.E.I. group of companies.

S/F407

THE ENGINEER

ESTABLISHED 1856

Vol. 198 No. 5152

OCTOBER 22, 1954

28, Essex Street, Strand, London, W.C.2.

Telephone : CENtral 6565 Telegrams : Engineer Newspaper, Estrand, London

Published every Friday Registered as a Newspaper

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NOTICE TO READERS
All letters intended for insertion in 'The Engineer or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications. No undertaking can be given to return drawings or manuscripts: correspondents are therefore requested to keep copies.

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

UNIVERSITY OF LONDON KING'S COLLEGE

RESEARCH STUDENTSHIP

University of London King's College offers a RESEARCH STUDENTSHIP to the value of £350 per annum, tenable for one year with possible renewal for a second year, made available by British Insulated Callender's Cables, Ltd. The Studentship is for research into the mechanical properties of powdered materials in relation to their use as electrical insulators. The character of the research is such that it should lead to a Higher Degree. Applicants should have a good Honours Degree in Engineering or Physics. Particulars and application forms from the Registrar, King's College London, Strand, W.C.2, whom completed forms must reach by November 22nd. E6180

MIDDLESBROUGH EDUCATION COMMITTEE

CONSTANTINE TECHNICAL COLLEGE

Principal: D. A. R. CLARK, M.Sc. (Tech.), M.I.Mech.E.

LECTURERS

Applications are invited for the following full-time appointments :—
LECTURER.
Engineering (preference will be given to applicants with experience in soil mechanics and geology).
ASSISTANT LECTURERS, Grade B.
Electrical Engineering.
Mechanical Engineering
Structural Engineering.
ASSISTANT LECTURER, Grade A.
Mechanical Engineering.
Salary: Burnham Technical Scale: Lecturer, £965 by £25 to £1065; Assistants, Grade B, £525 by £25 to £820; Assistants, Grade A, £450 by £18 to £725 (together with usual allowances for degree, training and industrial experience in case of Assistants). Forms and particulars obtainable from Director of Education, Woodlands Road, Middlesbrough, to whom completed applications should be returned within 14 days of the appearance of this advertisement. E6176

COUNTY BOROUGH OF WEST HAM EDUCATION COMMITTEE

WEST HAM COLLEGE OF TECHNOLOGY

ROMFORD ROAD, STRATFORD, E.15

Principal: E. A. RUDGE, Ph.D., M.Sc., A.M.I.Chem.E.

ASSISTANT LECTURER, GRADE A

Applications are invited for the post of ASSISTANT LECTURER, Grade A, in the Electrical Engineering Department. Candidates should have a Degree, or equivalent qualification, together with industrial experience, and should be able to teach in the field of electrical power and machines.
Salary in accordance with the Burnham Technical Scale (Grade A).
Forms of application and particulars may be obtained from the Principal on receipt of a stamped, addressed envelope and should be returned not later than 29th October. E6079

THE COLLEGE OF AERONAUTICS

DEPARTMENT OF AIRCRAFT PROPULSION

LECTURER

Applications are invited for the post of LECTURER in the Department of Aircraft Propulsion. Candidates should have advanced knowledge of some branch of thermodynamics or gas dynamics, and of the theory and performance of propulsion units, and some practical experience of one or more modern propulsion systems. They should possess a Degree and/or other recognised professional qualification. Salary within range £600–£1000 per annum, depending upon qualifications and experience, with superannuation under F.S.S.U., and family allowance. A small house on the College estate may be made available.—Applications, giving full details of qualifications, &c., and quoting the names of three referees, should be addressed to the Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks. Further particulars available. Closing date for applications 12th November, 1954. E6011

ROYAL AIRCRAFT ESTABLISHMENT TECHNICAL COLLEGE

ASSISTANT LECTURER IN GENERAL ENGINEERING SUBJECTS

ASSISTANT LECTURER IN GENERAL ENGINEERING SUBJECTS required by Royal Aircraft Establishment Technical College (selective), Farnborough, Hants.
Qualifications: University Degree in Engineering or equivalent, some industrial experience preferable. Salary payable in accordance with Burnham Scale for Grade A Assistants in Technical Colleges, £450 by £18 to £725, together with allowances for qualifications (£90 for a good Degree) and industrial experience (£18 for each year's experience) and subject to the Teachers' Superannuation Acts. Duties to commence as soon as possible. Details and forms from Principal, to whom completed forms must be returned within 14 days of this notice. E6121

PUBLIC APPOINTMENTS

SUDAN GOVERNMENT

KHARTOUM TECHNICAL INSTITUTE

ASSISTANT DIRECTOR TECHNICAL EDUCATION AND PRINCIPAL

The Director of Education invites applications for the post of ASSISTANT DIRECTOR TECHNICAL EDUCATION AND PRINCIPAL, Khartoum Technical Institute, which becomes vacant in January, 1955.
Applications will only be considered from candidates who have held a similar post for at least three years and have had administrative experience in implementing development schemes for technical education at various levels, preferably in colonial territories. In addition to the normal duties associated with the post, the successful candidate will be required to advise the Director of Education on the future expansion of technical education in the Sudan and also to be responsible for the overall administration of existing technical education facilities in the country.
This is the second advertisement for this post and those who have already applied are still under consideration.
Appointment will be on short term contract (with bonus) for five years, of which the first two will be a period of probation. Salary in the range of £E.2500 to £E.2800 per annum. A cost-of-living allowance which is reviewed quarterly is payable. Outfit allowance of £E.50 is payable on appointment. No income tax is at present payable in the Sudan. Free passage on appointment.
Further particulars and application form will be sent on application to The Sudan Agent in London, Sudan House, Cleveland Row, St. James's, London, S.W.1, quoting "Principal 1007," and name and address in block letters. E6069

INSTRUCTOR (MATHEMATICS AND MECHANICS)

MOMBASA INSTITUTE OF MUSLIM EDUCATION, KENYA

INSTRUCTOR (Mathematics and Mechanics) required by the Mombasa Institute of Muslim Education, Kenya, for one tour of three years in the first instance. Salary scale (including present temporary allowance of 30 per cent. of salary), £715, rising to £1325 a year. Commencing salary according to experience. Free furnished quarters or an allowance in lieu. Outfit allowance £30. Free passages. Superannuation scheme. Liberal leave on full salary. Candidates will be required to teach mathematics and mechanics to engineering students and should hold a B.Sc. (Eng.) or be A.M.I.Mech.E. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2A/40434/EH. E6118

COVENTRY TECHNICAL COLLEGE

FULL-TIME TEACHING STAFF

Required, earliest possible, following Full-time Teaching Staff. Candidates should be Graduates or hold good technical qualifications; previous teaching experience advantageous.
Mechanical Engineering Department.—ASSISTANTS, Grade A (3 vacancies). Applications considered from those experienced in some branch of Mech., Auto., Aero. or Production Engineering.
Mathematics Department: ASSISTANT, Grade A, mainly for part-time O.N.C. and trades courses.
Salary, Burnham Technical Scale (Grade A Assistants £450 by £18 to £725). Application forms from Director of Education, Council House, Coventry, returnable without delay. E6105

BRITISH ELECTRICITY AUTHORITY

GENERATION STATION CONSTRUCTION, CIVIL ENGINEERING BRANCH, HEADQUARTERS

SENIOR ASSISTANT ENGINEER

British Electricity Authority, Generation Station Construction, Civil Engineering Branch, Headquarters, London, require SENIOR ASSISTANT ENGINEER.
Duties include critical examination and reporting on the development of projects, procedure leading to letting of contracts, and consideration of prices and claims in respect of power station construction. Candidates should preferably be Corporate Members of the Inst.C.E. and have field experience on major civil engineering works with consulting engineers or contractors in Great Britain, preferably including work on power station construction. Knowledge is essential of methods of construction, administration of works contract practice and procedure, costing and pricing of work and adjustment of claims. Salary: N.J.B. Grade 1, £1002 to £1378, inclusive.
Applications, stating age, qualifications, experience, present position and salary, to D. Moffat, Director of Establishments, Winsley Street, London, W.1, by November 6th, 1954. Quote Ref. ENR./533. E6134

MANCHESTER CORPORATION

CITY SURVEYOR'S DEPARTMENT

ASSISTANTS

ASSISTANTS required in City Surveyor's Department, to work under the direction of the Divisional Engineers. Experience in civil engineering constructional work or land surveying desirable. Age limit 35 years. Salary £440/£520 per annum in Misc. Grade IV.—Applications, stating age, experience, &c., to the City Surveyor, Town Hall, Manchester, not later than 30th October, 1954. E6151

PUBLIC APPOINTMENTS

NEW ZEALAND

MINISTRY OF WORKS

ENGINEERING STAFF

The New Zealand Government invites applications for permanent appointment in New Zealand. Departments, positions, qualifications necessary and salaries (expressed in New Zealand currency) on appointment are :—
CIVIL ENGINEERING DIVISION
Vacancy No. 1, ENGINEERS.
Vacancy No. 2, ASSISTANT ENGINEERS.
A University Degree in Civil Engineering and/or Corporate Membership of the Institution of Civil Engineers, London. Salary on appointment from £665 for a graduate without experience, to £1242 per annum.
Vacancy No. 3, ENGINEERS' ASSISTANTS
General Certificate of Education (or equivalent) and substantial practical experience. Salary on appointment from £707 to £862 per annum.
Vacancy No. 4, TECHNICAL ASSISTANTS.
General Certificate of Education (or equivalent) and preferably with engineering laboratory experience in soil mechanics or the testing of concrete and concrete aggregates, &c. Salary on appointment from £522 to £802 per annum.
Vacancy No. 5, DRAUGHTSMEN.
Ordinary or Higher National Certificate and at least three years' experience at the drawing board. Salary on appointment from £665 to £1042 per annum. Also vacancies in the New Zealand Forest Service.
MECHANICAL ENGINEERING DIVISION
Vacancy No. 6, ENGINEERS (Mechanical and Building Services).
Corporate Membership of the Institution of Mechanical Engineers, London. Salary on appointment from £892 to £1402 per annum.
Vacancy No. 7, ASSISTANT ENGINEERS.
A University Degree in Mechanical Engineering or Graduate Membership of the Institution of Mechanical Engineers, London. Salary on appointment from £665 to £862 per annum.
Vacancy No. 8, ENGINEERS' ASSISTANTS.
Higher National Certificate in Mechanical Engineering and substantial practical experience. Salary on appointment from £707 to £862 per annum.
Vacancy No. 9, DRAUGHTSMEN (Mechanical and Building Services).
Ordinary or Higher National Certificate in Mechanical Engineering or equivalent. Salary on appointment from £665 to £922 per annum. Also vacancies for Mechanical Draughtsmen in the New Zealand Forest Service.
Vacancy No. 10, DRAUGHTSMEN (Electrical).
Ordinary or Higher National Certificate in Electrical Engineering. Salary on appointment from £665 to £742 per annum.
Further information, conditions of appointment and application forms obtainable on request from :—High Commissioner for New Zealand, 415, Strand, London, W.C.2, quoting reference No. 3/74/106, together with the vacancy number stated above and mentioning this paper.
Completed applications in duplicate, accompanied by copies only, also in duplicate, of two recent testimonials to be lodged not later than 31st December, 1954.
Appointing officers will arrive from New Zealand in January, 1955, to interview suitable applicants. E6101

NATIONAL COAL BOARD

MECHANISATION BRANCH OF PRODUCTION DEPARTMENT

FIELD DEMONSTRATING ENGINEER

National Coal Board invite applications for the superannuable appointment of a FIELD DEMONSTRATING ENGINEER in the Mechanisation Branch of Production Department at Headquarters.
The selected applicant will be required to assist with the installation of new mining machines, to acquaint himself with their construction and method of operation and to train personnel at the collieries in which they are installed in both operation and maintenance. The duties will involve spending a considerable proportion of the time in the coalfields.
Candidates should have had good experience as fitters or mechanics and be thoroughly acquainted with modern mining machinery. A recognised qualification in mechanical engineering would be an advantage. The successful candidate will be required to live in the Midlands.
Salary will be within a range £700–£1000 per annum, according to qualifications and experience.
Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope T7/858. Original testimonials should not be forwarded. Closing date 8th November, 1954. E6122

ELECTRICAL ENGINEER

ELECTRICITY AUTHORITY OF CYPRUS

The Electricity Authority of Cyprus require an ELECTRICAL ENGINEER for the two tours, each of 2 years, with prospect of permanency. Commencing salary in scale £1200, rising to £1500 a year, according to qualifications and experience. Free furnished quarters and passages. Liberal leave on full salary. Candidates, between 28 and 40, must have had sound training in both electrical and mechanical engineering with experience in the practical and administrative operation of electricity supply undertakings. They should possess competent knowledge of the operation and maintenance of 33kV. or 66kV. systems and the erection and maintenance of high and low voltage overhead and underground A.C. transmission systems, networks and substation plant. Preference will be given to Corporate Members of the Institution of Electrical Engineers. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2A/40498/EH. E6119

PUBLIC APPOINTMENTS

THE PUBLIC SERVICE OF THE UNION OF SOUTH AFRICA

ENGINEER EXAMINERS AND SURVEYORS

TWO ENGINEER EXAMINERS SURVEYORS are required by the Marine Department of Customs and Public Service.
Candidates must be citizens of a Commonwealth country or of the Republic of Ireland, and not less than 28 years of age on the 1st January
Candidates must be in possession of:
(a) A Certificate of Competency as an Engineer Class Engineer; or
(b) A Certificate of Competency as a Engineer (Steam and Motor) plus a Engineering of an approved University; qualified in examination and survey must be "confirmed" as Engineer Ship Surveyors.
The pensionable salary to be paid to applicants will be not less than £1800 plus cost-of-living allowance.
Candidates who are not qualified in and survey duties, but who possess at least cate of Competency as First Class Engineer and Motor), may be accepted as "trainees" case they will be required to obtain the Competency as Extra First Class Engineer qualify in examination and survey duties period of three years. Candidates may some assistance to this end.
The salary applicable to "Trainee Engineers" be on the following basis :—
(i) If in possession of a Certificate of Competency as First Class Engineer (Steam and Motor) per annum;
(ii) If in possession of either a Certificate of Competency as Extra First Class Engineer or a Certificate of Competency as First Class Engineer (Steam and Motor), plus a Degree in Engineering of an approved University, £1140 per annum.
"Trainees" who qualify on or before the end of the three-year period will become eligible for permanent appointment to the posts with the minimum of the scale, £1200 by £60 to £1440.
A cost-of-living allowance of £234 per annum (married officers) is payable at present. Further details are obtainable from the Commissioner of Customs and Excise, Marine Section, P.O. Box 298, Pretoria, South Africa, to whom applications should be addressed to reach him not later than 1st November, 1954.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

ALDERMASTON, BERKS

ENGINEERS (MAIN GRADE)

The United Kingdom Atomic Energy Authority, Aldermaston, Berks, requires ENGINEERS (MAIN GRADE) as follows :—
POST 1 (256/WGE/25).—To take charge of a group on the design, engineering and operation in field trials of ultra high-speed display systems. Experience of ultra fast circuits, millimicrosecond pulses, and wide band amplifiers essential, and experience in large-scale trials an advantage.
POST 2 (259/WGE/25).—To organise and control the supply and manufacture of a wide range of electronic apparatus on development or other contract and maintain active liaison with contractors on all aspects of the work. Applicants should have had a recognised engineering apprenticeship and equivalent experience in a suitable trade. Corporate Members of the Institution of Electrical Engineers or have exempting qualifications. Successful candidates will be expected to serve a period of outstation duty at Fort Halstead. The salary range is £960–£1240 (male) plus Houses available within a reasonable distance for married staff who live outside the Estate. Good transport facilities.—Application form from Recruitment Officer, A.W.R.E., Aldermaston. Quote appropriate reference number.

BRITISH ELECTRICITY AUTHORITY

TRANSMISSION DESIGN BRANCH

POWER CIRCUIT ENGINEER

British Electricity Authority, Transmission Design Branch, Headquarters, London, require a POWER CIRCUIT ENGINEER to co-ordinate the work of two small groups of engineers responsible for the design, specification and testing of overhead lines and cables. Candidates should have specialised experience with one of these types of equipment and a good knowledge of the practice and principles associated with the other. Good personality and initiative. To keep abreast of modern developments of great importance.
Salary, N.J.M. Scale 4, £1650 by £50 to £1850 inclusive of London allowance. Candidates should preferably be Corporate Members of the Institution. Forms from D. Moffat, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, to be returned by November 6th, 1954. Ref. ENR./532.

BRITISH RAILWAYS

PADDINGTON

STRUCTURAL DRAUGHTSMEN

British Railways have vacancies for STRUCTURAL DRAUGHTSMEN at Paddington. Applicants should be experienced in the design of bridges and structures. Posts offer pensionable opportunity for promotion and carry allowance of superannuation and rail-travel privileges, giving age, experience and qualifications, to Engineer's Office, Paddington, London, W.

THE ENGINEER

OCTOBER 22, 1954

Woolwich Arsenal

IN our issue of March 5th last, we recorded the principal recommendations of an inter-departmental committee appointed by the Minister of Supply to consider the future of Woolwich Arsenal. The committee suggested the sale of about 100 acres on the south side of the Arsenal for use as an industrial estate. Last Tuesday, at a meeting of the London County Council, a report was submitted by the L.C.C. town planning committee which states that negotiations with the Ministry of Supply have now reached a stage at which the L.C.C. can be recommended to proceed with the purchase of an area of about 118 acres. This property includes two groups of single-storey industrial buildings suitable for permanent retention, a number of buildings which after repair would be suitable for letting pending redevelopment, and land which will be sold to the L.C.C. cleared of all buildings and waste materials. The report says that the buildings and land will become available by stages over a period of some nine months from January, 1955, and the Ministry of Supply has agreed so to arrange its activities in other parts of the Arsenal that development will not be restricted because of danger zoning. It is understood that the Board of Trade is prepared to co-operate in the re-location in the area of industry tied to London. The report emphasises, however, that the L.C.C. cannot accept responsibility for dealing with employment problems which may arise in the area as a result of the contraction of Government operations at the Arsenal. At the same time, it is fully recognised that larger firms in such industries as engineering are likely to provide the best source of employment of redundant Arsenal labour and would provide a solid backbone to the estate. The town planning committee's report also makes reference to other problems concerned with the development of this estate, as, for example, the maintenance and management of the railway lines crossing the site which are connected with the main Arsenal system, the extent to which the L.C.C. itself should undertake the erection of new industrial buildings, and the limitations and conditions to be imposed on lettings to industrial firms. The purchase price which has been agreed for the unencumbered freehold and leasehold interests in the land is £800,000. Improvements will be necessary to the accesses at the western and eastern ends of the estate at an estimated cost of £155,000, and expenditure on internal road, drainage and other works is put at about £350,000. It is thought, therefore, that about £1,450,000 will be required to cover the cost of acquisition, clearance and partial development.

Institution of Mechanical Engineers

LAST Thursday the Institution of Mechanical Engineers held its annual dinner at the Dorchester Hotel, London. The toast of "The Institution" was proposed by Lord Chandos. He remarked that engineers could point to an ever-increasing rate of advance in the material world. But he had to confess that politicians had had little success in improving the relations between man and man. Indeed, he was sceptical whether any human progress had been made in that field at all. Besides, though engineers perfected inventions, very little study was made of the way they ought to be used by mankind. In fact, it was engineers who had created an "artificial" economy. It would therefore be a very good thing if technologists paid a little more attention to the "humanities." In his reply, Dr. Bailey, president of the Institution, made particular reference to the way in which, particularly during and since the war, the three major engineering institutions have co-operated. The toast of "The Guests" was proposed by Mr. P. L. Jones, vice-president. In reply, General Sir Brian Robertson stressed the advantages young men gained from service in the Royal Electrical and Mechanical Engineers. They gained in skill in their trades and in character generally. He went on to remark that these were critical days for railways all over the world. New ideas were being formulated, both in the traction and construction sides. Something must be done to modernise British Railways, and he hoped soon to be able to produce some overall ideas to that end. He ended by stressing that there was plenty of chance for young engineers to gain responsible posts and the opportunity of advancement in British Railways.

"Comet" Investigations

IN connection with the Court of Inquiry, which opened on Tuesday on the "Comet" disasters, we were invited to the Royal Aircraft Establishment at Farnborough to see some of the techniques and equipment used there on the investigations. The principal item in this programme was the pressurised hydraulic tank, which was built around the fuselage of an almost complete "Comet" aircraft. This steel structure is 112ft long, 16ft wide and 12ft high, with a water capacity of 200,000 gallons. Where the wings protrude from the structure, special flexible seals were developed, part of which consist of a pneumatic collar glued around the wing profile at the tank walls. With this arrangement it was possible to simulate gust loading on the wings whilst cycles of pressurisation and depressurisation were applied to the fuselage. The maximum pressure of 8¼ lb per square inch was obtained by pumping about 100 gallons further into the fuselage. Both the tank and the fuselage were filled with water to remove any static pressure differentials. It is believed to be the first time that the full landing to take-off cycle has ever been simulated on a complete full-scale aircraft. The load cycle was continued until the fatigue life of both the wing and the fuselage were determined. The flight loading cycle simulated included half an hour take-off and climb, two hours cruising at altitude, and half an hour descent and landing, each three-hour cycle taking five minutes in the rig. Twenty-five cycles of gusts at ±25ft per second were simulated by hydraulic rams in the manner already described in these columns in connection with earlier tests on the "Comet." Two other "Comet" aircraft were used on the flight testing programme, and we understand that these aircraft were probably the most heavily instrumented machines ever to fly. Both flew unpressurised, and some seventy flights were made to determine the h.f. and l.f. vibration levels in flight and the temperatures and stresses occurring in the structure. Using many dozens of dynamically similar models, an attempt has been made to study the disintegration pattern of the "Comet." Each model was so jointed that by pulling dowels out attached to strings a particular kind of failure after launching could be induced, and the subsequent sequence of disintegration and the final scatter on the ground could be analysed. By comparing the size and distribution patterns with those actually plotted from "Comet" wreckage it was hoped that some impression of the actual failure sequence could be deduced.

Lloyd's Shipbuilding Returns

LLOYD'S REGISTER SHIPBUILDING RETURNS have been published for the quarter ended September 30th last. The work in hand in Great Britain and Northern Ireland amounted to 316 steamships and motorships of 2,058,457 tons gross, a decrease of 136,628 tons compared with the previous quarter, of which eighty-six ships of 578,919 tons were afloat and 230 ships of 1,479,538 tons were still to be launched. During the quarter fifty-three ships of 250,453 tons were commenced, sixty-two ships of 395,148 tons were launched while sixty-five ships of 389,436 tons were completed. Of the total tonnage being built 32·7 per cent is for registration abroad. Oil tankers totalled eighty-three ships of 1,093,530 tons, representing 53·1 per cent of the tonnage under construction. The amount of tonnage for which plans have been approved was 1,579,477 tons and represented a decrease of 111,558 tons since the previous quarter and a considerable reduction from the peak figure of 2,684,263 tons in September, 1952. Excluding China, Poland and Russia, the work in hand abroad totalled 749 ships of 3,440,621 tons gross, a decrease of 213,185 tons since the end of June, and during the quarter 233 ships of 890,257 tons were commenced, 223 ships of 737,047 tons were launched, while those completed totalled 260 ships of 1,115,751 tons. Some 175 oil tankers, representing 2,125,230 tons and 61·8 per cent of the total tonnage, were under construction. Throughout the world 1065 steamships and motorships of 5,499,078 tons gross were under construction, 37·4 per cent of which were building in Great Britain and Northern Ireland, indicating a decrease of 349,813 tons compared with the preceding quarter. The total included seventy-one ships of between 6000 and 8000 tons; fifty-two ships between 8000 and 10,000 tons; 144 ships between 10,000 and 15,000 tons; forty-one ships between 15,000 and 20,000 tons; forty-six steamships and three motorships between 20,000 tons and 30,000 tons, and one steamship of 31,000 tons. The world construction of oil tankers amounted to 258 ships of 3,218,760 tons and 58·5 per cent of the total tonnage building. The tonnage under construction in Great Britain and Northern Ireland consisted of 1,153,772 tons of steamships and 904,685 tons of motorships, while the corresponding figures for construction abroad were 1,561,484 tons and 1,879,137 tons respectively.

British Coal Utilisation Research Association

THE annual luncheon of the British Coal Utilisation Research Association was held on Wednesday, October 13th, at the Connaught Rooms, London, W.C.2, and was attended by over 300 members and their guests under the chairmanship of Sir Charles Ellis. The toast of "The B.C.U.R.A." was proposed by the Honourable Lancelot Joynson-Hicks, M.P., who contrasted the days when the problem was to find ways to use coal with the present need to conserve it. Smoke, he said, indicated inefficient use of coal which meant waste of fuel and money. He suggested that an incentive in combating air pollution was the overall financial saving resulting from having a cleaner atmosphere. Industry, he continued, by taking full advantage of technical advice to achieve greater efficiency in the use of coal, could save as much as 25 per cent on its fuel bill. As an example of waste, he called attention to the millions of tons of sulphur wasted by release into the atmosphere, while valuable dollars were being spent on importing sulphur from America. In his reply, Sir Charles Ellis, the president of the Association, touched upon the work of the Association and stressed the part played by instruments in research. Intellectual curiosity, he commented, was an invaluable asset in making progress, and he felt that its absence was the root cause of dull routine work. Sir Charles referred to the thought behind the coal science lectures and went on to emphasise that the subject of the lectures, the structure of coal, was not a theoretical but a practical problem. At the conclusion of his remarks, Sir Charles presented the third Coal Science Medal to Professor D. W. van Krevelen, the Director of Research, Central Laboratory, Dutch State Mines.

Drafting and Observance of Train Schedules

By W. A. TUPLIN, D.Sc., M.I.Mech.E.

A rational time schedule for a train over any route can be calculated if the power/speed characteristics of the locomotive and the resistance/speed characteristics of the train are known. Generous allowances must be made for locomotives in imperfect condition and for the increase in train resistance in unfavourable weather conditions. Existing information about the running of trains of all descriptions over any route in actual service is the most reliable basis of any calculations of a new timing over that route. The technique of controlled road testing of locomotives might be usefully applied to the problem of determining the details of enginemen's procedure for observing schedules in the most economical way.

THERE are many factors which influence the practicable schedule times of a railway train and, of these, none is more important than the power available for the purpose. To determine what minimum time is practicable with a given locomotive and train over a particular road is an example of what is sometimes called a design problem, which is the inverse of the usually simpler problem of estimating the probable performance of a completed design or in this case estimating the power required to haul a train past certain points at certain times.

This particular estimate clearly depends on a knowledge, however approximate it may be, of train resistance, and in the first part of this article the formula due to Johansen (*Proc. I.Mech.E.*, Vol. 134, 1936, page 91), applying to L.M.S. passenger vehicles of that period is taken as a reasonable basis. For speeds between 30 and 80 m.p.h. the resistance in pounds per ton is about $0{\cdot}2\,M$ for coaches and $(5+0{\cdot}3\,M)$ for locomotive and tender, M being the speed in miles per hour. For some purposes it is sufficiently accurate, and much more convenient to replace $(5+0{\cdot}3\,M)$ by $0{\cdot}4\,M$.

The effect of gradients on power requirements is calculable, as accurately as weights of trains and heights of track above sea level are known, and this is useful, as in many circumstances gravity is an important factor in the total resistance opposed to the locomotive.

Effect of Gradient on Average Power.—A simple example illustrates a principle to be taken into account when scheduling times over a road with gradients. The imaginary case considered is one in which start and finish are at a common height above sea level, with a summit halfway between them, and approached in each direction by a uniform gradient of 1 in 200. The distances are long enough for the acceleration and deceleration periods to be a negligible fraction of the total.

As train resistance has a component (largely air resistance) that increases with speed, whilst the net effect of gravity on this journey is zero, the minimum total work is required when the speed is constant, (e.g. 75 m.p.h.) at all points, but this clearly demands more power on the upgrade than on the downgrade.

On the other hand, the minimum value of maximum power required is secured by running at constant power output, the speed uphill then being lower than that downhill.

The drawbar horsepower required and the work done for each of these conditions are shown in lines 6 to 10 in the first two columns of Table I. The third column shows an intermediate method of making the trip ; neither speed nor power is constant throughout and neither the work done nor the maximum speed is as low as it might be.

Case 1 is desirable in minimising work done and maximum speed, but it demands a larger locomotive than suffices for either of the other schedules. This point is taken into account in lines 11 to 13. Current practice shows that a locomotive can sustain about 12 d.h.p. per ton weight of engine and tender. In Case 1, where 5·25 d.h.p. per ton of train is required, the weight of engine and tender will be about $5{\cdot}25/12=0{\cdot}44$ ton per ton of

TABLE I—*Effect of Gradient on Average Power*

Haulage over 37½ miles at 1 in 200 up followed by 37½ miles at 1 in 200 down

	Case	1	2	3
	Speed (m.p.h.) :			
2	Up	75	58·5	64·5
3	Down	75	104·5	90·0
	Time (min.) :			
4	Up	30	38·5	35
5	Down	30	21·5	25
	D.h.p. per ton :			
6	Up	5·25	3·55	4·15
7	Down	0·75	3·55	1·9
	D.h.p. min. per ton of train :			
8	Up	157·5	137	145
9	Down	22·5	76·5	47·5
10	Total d.h.p. min. per ton of train	180	213·5	192·5
11	Weight of engine and tender per ton of train (tons)	0·44	0·3	0·35
12	Equivalent total weight for resistance per ton of train (tons)	1·88	1·6	1·7
13	Total i.h.p. min.	340	340	327
14	Max. i.h.p. per ton of train	9·9	5·7	7·7

train. Taking the approximate Johansen figure, the running resistance of engine and tender is equivalent to that of an extra $2\times0{\cdot}44=0{\cdot}88$ ton per ton of train. Each figure in line 13 is the product of these in lines 10 and 12 in the same column.

Case 2 is undesirable in its high downhill speed, in power dissipation, wear and tear, and braking distance.

Case 3 represents a practical compromise and does in fact approximate to normal running of the L.N.E.R. streamlined trains in the years 1935–1939. As compared with running over level track it requires 192·5 h.p. min. per ton instead of 180 for uniform speed and this extra 7 per cent is the same as would be demanded at 75 m.p.h. by a continuous upgrade of only 1 in 2150.

This shows that between points at a common height the effect of undulations on mean power required is small ; the shorter the undulations at a given inclination the less extra they demand. (If the length of an undulation were equal to that of the train the gradients would have no effect, as at every instant half the train would be on an up gradient and the other half on a down gradient.)

Line 13 in Table I shows that the total work to be done on the pistons is about the same for all three cases considered, but line 14 shows very considerable differences in maximum power demand on the locomotive. Case 3 is likely to be preferred, as it avoids both the need for the largest locomotive and for speeds over 90 m.p.h.

Effective Weight of Locomotive and Train.—Table I shows that, especially where the scheduled speed is high, the weight of locomotive and tender is a substantial fraction of the total moving weight. As the ratio of running resistance to weight is not the same for locomotive and train, the two must be considered separately where acceleration or gradient is an important factor. It is found, however, that even in an extreme case it is reasonable to take the running resistance of engine and tender as twice that of a train of the same weight ; up to speeds of about 80 m.p.h. the error is less than 4 per cent.

So far as acceleration and gradient are concerned the total weight to be considered is W_e+W_t,
where

W_e=Weight of engine and tender (tons),

and

W_t=Weight of train (tons).

For resistance purposes the total weight is $2W_e+W_t$.

Sustained Speed with Given Power.—For a constant speed of M m.p.h. up a gradient of 1 in G the Johansen formula shows that the horsepower required per ton of train is about $M^2/1900$ in the normal running range and so the indicated horsepower is given by

$$H=\frac{6M}{G}(W_e+W_t)+\frac{M^3}{1900}(2W_e+W_t)$$

From this,

$$M=\sqrt{\left[\left(\frac{5700}{G}\,\frac{W_e+W_t}{2W_e+W_t}\right)^2+\frac{1900\,H}{2W_e+W_t}\right]}-\frac{5700}{G}\left(\frac{W_e+W_t}{2W_e+W_t}\right) \quad . \; . \; . \; (1)$$

Equation (1) gives the sustained speed possible up a gradient of 1 in G with H indicated horsepower.

Average Effect of Non-Uniform Gradients.—With a specified power per ton the time taken between two points connected by a continuous rise with such variations in gradient as normally occur in practice is (for estimating purposes) the same as if the gradient were uniform. This is illustrated by a simple example.

Case A.—Gradient composed of 10 miles up at 1 in 200 and 10 miles up at 1 in 100, with $W_e=130$, $W_t=400$ and $H=1800$. Speed on 1 in 200,

$$M_1=\sqrt{\left[\left(\frac{5700}{200}\times\frac{530}{660}\right)^2+\frac{1900\times1800}{660}\right]}-\frac{5700}{200}\times\frac{530}{660}=52{\cdot}6.$$

$$\text{Time } T_1=\frac{10}{52{\cdot}6}\times60=11{\cdot}4 \text{ min.}$$

Speed on 1 in 100 is similarly

$M_2=39{\cdot}4$, $T_2=15{\cdot}2$ min, total 26·6 min.

Case B.—Uniform gradient between the same points is

$$\frac{1}{20}\left[\frac{10}{200}+\frac{10}{100}\right]=\frac{1}{133}$$

and by the same procedure it is found that $M_3=45{\cdot}5$, $T_3=26{\cdot}4$ min.

Hence the assumption of uniform gradient in this rather severe case in which one-half is twice as steep as the other overestimates the attainable average speed by a negligible amount of about ¾ per cent, which is considerably smaller than errors due to unavoidable uncertainties in the method.

Effect of Periods of Acceleration and Retardation on Total Time.—The foregoing is based on the assumption of constant speed on uniform gradient. The effect of kinetic energy in tending to keep speed uniform despite change of gradient is to reduce the already small error in taking the average of a

succession of up gradients as the equivalent uniform gradient.

In starting from rest or from speeds much below the general average the time lost during acceleration may, however, be significant on short runs. The time lost during deceleration as compared with an instantaneous stop from full speed also merits consideration, although it is usually much less important than that lost during acceleration.

Allowance for Acceleration from Rest.—In considering acceleration from rest it is assumed that the initial acceleration is that produced by a starting effort equal to the locomotive's adhesion weight multiplied by a coefficient of friction of 0·15 and that the acceleration falls parabolically to zero when the speed reaches that which the power of the locomotive can maintain on the gradient concerned. It can be shown that this assumption corresponds to a mean speed during the acceleration period equal to three-quarters of the maximum speed (V) and to a loss of time, as compared with full-speed running during the acceleration period, of $\frac{1}{2}V/a$, where a is the initial acceleration. The distance covered during the acceleration period is $\frac{9}{4}V^2/a$.

Let

$$b=\frac{\text{Total moving weight}}{\text{Adhesion weight of locomotive}}$$

$$c=\frac{\text{Weight of engine and tender}}{\text{Total moving weight}}$$

M=Maintained speed (m.p.h.) on the gradient.

Then

Initial acceleration α

$$=\left(\frac{\text{Tractive force}}{\text{Total weight}}-\frac{1}{G}\right)32 \text{ f.s.s.}$$

$$=\left(\frac{0\cdot15}{b}-\frac{1}{G}\right)32=\frac{4\cdot8}{b}-\frac{32}{G} \text{ f.s.s.}$$

Then distance over which acceleration takes place is

$$S=\frac{9}{4}\left(M\times\frac{88}{60}\right)^2\frac{1}{\alpha}=4\cdot85\frac{M^2}{\alpha}\text{ft.}$$

$$=\frac{1}{\alpha}\left(\frac{M}{33}\right)^2 \text{ miles} \quad . \quad . \quad (2)$$

The loss of time as compared with running at M m.p.h. over this distance is

$$\frac{3}{4}\frac{V}{a}=\frac{3}{4}\left(M\times\frac{88}{60}\right)\cdot\frac{1}{\alpha}=\frac{1\cdot1M}{\alpha}\text{sec.} \quad . \quad . \quad (3)$$

Alternatively the loss of time in the acceleration period may be regarded as equivalent to an extra distance equal to

$$\left(\frac{1\cdot1M}{\alpha}\right)\frac{M}{3600}=\frac{1}{\alpha}\left(\frac{M}{57}\right)^2 \text{ miles.}$$

Allowance for Recovery from Reduced Speed.—Acceleration from a reduced speed m to full speed M takes place in time and distance determined by the difference between the corresponding quantities for acceleration from rest to M and from rest to m. Hence

$$\text{Distance}=\left[\left(\frac{M}{33}\right)^2-\left(\frac{m}{33}\right)^2\right]\frac{1}{\alpha}\text{miles} \quad . \quad (4)$$

$$\text{Loss of time}=\frac{1\cdot1}{\alpha}(M-m)\text{ sec.} \quad . \quad . \quad . \quad (5)$$

Allowance for Beginning Gradient at Higher than Sustained Speed.—Application of methods already used makes it possible to calculate the gain in time by entry on a gradient at a speed (M_0 m.p.h.) that is higher than the sustained speed M.

The available power per ton is $\frac{6M}{G}+\frac{M^2}{1900}$ and the corresponding pull at M m.p.h. is

$$\frac{\text{H.P.}\times375}{\text{Speed (m.p.h.)}}\text{lb}=\frac{375}{M}\left(\frac{6M}{G}+\frac{M^2}{1900}\right)\text{lb per ton.}$$

The corresponding pull at M_0 m.p.h. is

$$\frac{375}{M_0}\left(\frac{6M}{G}+\frac{M^2}{1900}\right)\text{lb per ton.}$$

Hence the initial retardation is

$$\frac{375}{2240}\left(\frac{6M}{G}+\frac{M^2}{1900}\right)\left(\frac{1}{M}-\frac{1}{M_0}\right)g$$

and the mean retardation (one-third of this)

$$\gamma=1\cdot8M\left(\frac{6}{G}+\frac{M}{1900}\right)\left(\frac{M_0-M}{M}\right)\text{f.s.s.}$$

$$\text{Time of retardation period}=\frac{88}{60}\frac{(M_0-M)}{\gamma}\text{sec.}$$

Distance covered during retardation

$$=\left(\frac{88}{60}\right)^2\left(\frac{M_0-M}{\gamma}\right)\left(\frac{M_0+M}{2}\right)\text{ft (approx.)}$$

. . . . . (6)

The time-gain for this period is the time occupied in covering this length at M m.p.h. less the actual time, i.e.

$$\frac{88}{60\times2\gamma M}(M_0-M)(M_0+M)-\frac{88}{60}\left(\frac{M_0-M}{\gamma}\right)$$

$$=\frac{88}{60}\frac{(M_0-M)}{\gamma}\left[\frac{M_0+M}{2M}-1\right] \quad . \quad . \quad . \quad . \quad (7)$$

Loss of Time in Braking from One Speed to Another.—Assuming that 75 per cent of the total weight of the train is braked and that the mean coefficient of friction for braking purposes is 0·1, the deceleration during braking up a gradient of 1 in G is

$$\beta=\left[0\cdot1\times0\cdot75+\frac{1}{G}\right]32=2\cdot4+\frac{32}{G}\text{f.s.s.}$$

. . . . . (8)

Basing on constant acceleration at this mean figure, for a reduction from M to m m.p.h.,

$$\text{Time required}=\frac{88}{60}\left(\frac{M-m}{\beta}\right)=\frac{M-m}{0\cdot68\beta}\text{ sec.}$$

. . . . . (9)

Distance covered

$$=\left(\frac{88}{60}\right)^2\left(\frac{M^2-m^2}{2\beta}\right)\frac{1}{5280}=\frac{M^2-m^2}{4915\beta}\text{ miles}$$

. . . . . (10)

Time required at M m.p.h.

$$=\frac{M^2-m^2}{0\cdot93\beta}\left(\frac{60}{88M}\right)\text{sec.}$$

Loss of time

$$=\frac{1}{\beta}\left[\frac{M-m}{0\cdot68}-\frac{M^2-m^2}{1\cdot36M}\right]=\frac{M-m}{1\cdot36\beta}\left[2-\frac{M+m}{M}\right]$$

$$=\frac{1}{3\cdot26+43\cdot5/G}\frac{(M-m)^2}{M}\text{ sec.} \quad . \quad . \quad (11)$$

Numerical Example:—

Weight of train, 500 tons.
Weight of engine and tender, 150 tons.
Adhesion weight of engine, 65 tons.
Sustained i.h.p., 2000.

It is required to estimate the times at points B and C, from a standing start at point A on a road with the following gradients.

A–B, 10 miles up at 1 in 150.
B–C, 15 miles down at 1 in 250
Speed restricted to 30 m.p.h. at C.
Height of B above datum, 352ft.
Height of C above datum, 35ft.

For resistance purposes, the effective weight of engine and tender is $150\times2=300$ tons. For inertia effects and gravitational effects the total weight is $500+150=650$ tons.

Hence,

$$W_e+W_t=650$$
$$2W_e+W_t=800$$
$$b=\frac{500+150}{65}=10.$$

Section A–B.—From (1) the sustained speed is

$$M_1=\sqrt{\left[\left(\frac{5700}{150}\times\frac{650}{800}\right)^2+\frac{1900\times2000}{800}\right]}$$
$$-\frac{5700}{150}\times\frac{650}{800}=44\cdot5$$

The time required for the 10 miles at this speed

$$=\frac{10}{44\cdot5}\times3600=810\text{ sec.}$$

From (2) the distance covered during acceleration is

$$\frac{1}{\frac{4\cdot8}{10}-\frac{32}{150}}\left(\frac{44\cdot5}{33}\right)^2=6\cdot8\text{ miles.}$$

As this is less than 10 miles, the full speed of 44·5 m.p.h. is reached and maintained to the summit B.

From (3) the loss of time at starting is

$$\frac{1\cdot1\times44\cdot5}{\frac{4\cdot8}{10}-\frac{32}{150}}=183\text{ sec.}$$

Hence,

Total time to point B=810+183=993 sec.

Section B–C.—From (1),

$$M_2=\sqrt{\left[\left(\frac{5700}{-250}\times\frac{650}{800}\right)^2+\frac{1900\times2000}{800}\right]}$$
$$-\frac{5700}{-250}\times\frac{650}{800}=89\cdot7\text{ m.p.h.}$$

From (4) the distance covered during acceleration from point 1 is

$$\left[\left(\frac{89\cdot7}{33}\right)^2-\left(\frac{44\cdot5}{33}\right)^2\right]\frac{1}{\frac{4\cdot8}{10}-\frac{32}{-250}}=9\cdot16\text{ miles.}$$

From (10) the distance covered during deceleration to 30 m.p.h. at point C is

$$\frac{89\cdot7^2-30^2}{4915\left(2\cdot4+\frac{32}{-250}\right)}=0\cdot64\text{ miles.}$$

The total distance covered during acceleration and deceleration is thus 9·16+0·64=9·8 miles, leaving 15—9·8=5·2 miles run at the sustained speed of 89·7 m.p.h.

From (5) the loss of time in acceleration is

$$\frac{1\cdot1}{\frac{4\cdot8}{10}-\frac{32}{-250}}(89\cdot7-44\cdot5)=82\text{ sec.}$$

From (11) the loss of time in deceleration is

$$\frac{1}{3\cdot26+\frac{43\cdot5}{-250}}\frac{(89\cdot7-30)^2}{89\cdot7}=13\text{ sec.}$$

Time for 15 miles at 89·7 m.p.h.

$$=\frac{15}{89\cdot7}\times3600=600\text{ secs.}$$

Actual time for B–C

$$=600+82+13=695\text{ sec.}$$

Result.—

Time from A to summit B =993 sec.
Time from A to C =993+695
=1688 sec.
Average speed from A to B=36·2 m.p.h.
A to C=53·4 m.p.h.

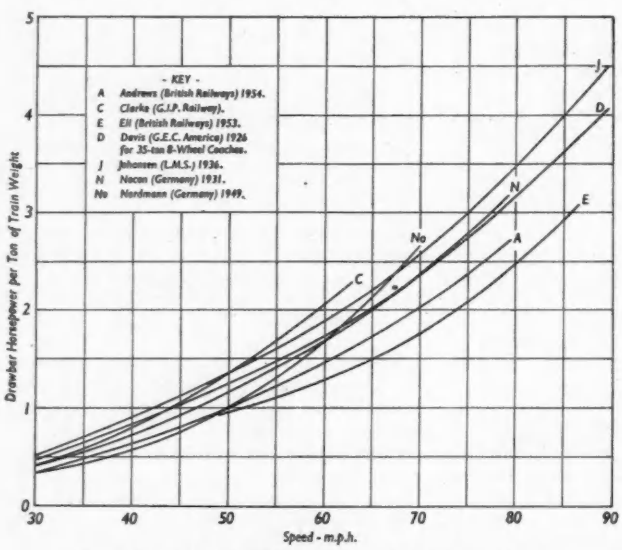
General.—At the expense of a little arithmetical labour it is possible to estimate the times attainable over any given road with specified power and load if reliable information is available about train resistance. The foregoing analysis is based on the Johansen formula in calm air ; a wind at 20 m.p.h. in the most unfavourable direction may increase the resistance of a train running at 60 m.p.h. by about 50 per cent. It is necessary, therefore, in formulating a schedule to decide what are the worst wind conditions that must be accepted as a normal possibility, and to estimate their effect on the running, as some routes are more sheltered than others by cuttings and other topographical features. Such an allowance may be but little better than a guess and the same may be said of any account that may be attempted of the

additional resistance caused by curved track.

A special condition to which the normal formulæ for resistance and acceleration are scarcely applicable is that of starting a journey with a "cold" engine up a steep gradient with slippery rails; the descent of the same gradient into a terminus precludes such a quick stop as is feasible with normal rail conditions at a wayside station.

The best, and perhaps the only, way to take account of such conditions is to observe the normal running of trains in ordinary service at the place concerned and this reflection leads to the comment that the same method could be applied to the whole schedule.

There is such a fund of detailed information available on the actual running of passenger trains in ordinary service on every main line in Great Britain that there is no need to look any further for reliable guidance in predetermining rational intermediate times for any overall journey time that represents a practicable advance on previous standards. It is not too much to say that a new schedule might be worked out arithmetically on the basis of statistical information even by someone who knew nothing of the physical interpretations of the figures. Certainly no new schedule, however determined, should be accepted if it conflicts with proved practice on the same route, and any schedule, even after acceptance, may be capable of improvement by modification made in the light of experience with it.



Comparison of formulæ for train resistance suggested by various authorities

When the uncertainties associated with fundamental analysis are considered in conjunction with the ease of alternative methods, it is hard to see why the development of a procedure for testing locomotives should be regarded as originating a means of rationally devising running schedules for trains. (This was a suggestion made by Mr. O. S. Nock in commenting in THE ENGINEER, February 5, 1954, page 205, on Mr. S. O. Ell's paper on locomotive testing.) On the contrary the one feature of Mr. Ell's paper that has any obvious connection with schedule framing raises additional doubts about its practicability on the basis of mechanics alone. This is the fact that a particular Western Region test showed train resistance to be considerably lower than was found by Johansen in L.M.S. coaching stock not substantially different from that of the Western Region. Furthermore, Dr. H. I. Andrews, in a paper presented to the Institution of Locomotive Engineers on February 10, 1954, gave, for British Railways passenger vehicles, resistance figures lying between those of Johansen and those of Ell.

The diagram herewith summarises resistance figures of railway passenger vehicles published by a number of investigators. The variation between them emphasises that the uncertainty about resistance far outweighs that in any other factor that affects the planning of a schedule. With, for example, 2 h.p. per ton available, the latest figures would suggest that a sustained speed of 70 m.p.h. is possible on the level as against 62 m.p.h. and 64 m.p.h. by the formulæ of Johansen and Davis respectively.

It would seem prudent in framing schedules to base on something more than the minimum train resistance and the Johansen formula appears reasonable for the purpose.

Observance of Schedules.—In principle every train schedule is based on the assumption, tacit or otherwise, that the locomotive is capable of developing a certain power output for certain periods. A virtue of the Western Region locomotive testing technique, as of others, is that it enables the power capacity of a locomotive to be determined in controlled running conditions on the road. A characteristic of it is that, within a limitation mentioned later, the engine driver himself is enabled to keep the indicated horsepower of the locomotive within a narrow range. This is essential for testing purposes, but is not necessarily a rational procedure in actual service over an undulating road. Furthermore, its application as a testing technique is possible only on a road so easily graded that no excessive speed is produced by development of the full indicated horsepower on the downgrades.

Control of Steam Rate.—A special feature of the Swindon testing technique is the use of blast pipe pressure as a measure of rate of steam discharge and therefore, in turn, of draught, combustion rate, and evaporation rate. So long as the blast pipe pressure is kept constant and draught resistance and boiler efficiency are kept constant then the evaporation rate remains constant.

It is important to note, however, that in those circumstances the indicated horsepower remains constant only so long as the cylinder efficiency is constant and, with varying train resistance by change in gradient, this is possible only if the cut-off can remain between the approximate limits of 15 and 25 per cent.

In the Swindon road-testing procedure, blast pressure is indicated to the driver by a sensitive manometer, pulsations being suppressed by the long pneumatic connection, and its indication is a precise alternative to a driver's normal assessment of power development, which is the sound of the exhaust. An intermediate device is the back pressure gauge (common in American practice), but that is perhaps less reliable at low blast pipe pressures than is the manometer which, however, is probably not at all an instrument for everyday use. In any case, gradual sooting of fire-tubes between successive cleanings and gradual fouling of the blast pipe by carbonaceous deposits over longer periods are likely in actual service to cause appreciable departures from the original significance of any particular blast pipe pressure.

Firing of Locomotives.—The skill, energy and endurance of the fireman are fundamental to the best performance of a steam locomotive, but in few reports on locomotive testing is this obviously recognised. Mr. S. O. Ell's paper on the development of locomotive testing is an exception and in fact the maintenance of an "optimum firedbed" is an important factor in the success of the testing technique. Constancy of draught resistance through the fire bed at least is essential because otherwise constant blast pressure does not necessarily imply constant gas flow.

A valuable object for a series of closely controlled tests would be the establishment of details of the optimum fire bed for a variety of coals and power outputs for each class of locomotive. What is needed is some such statement as that the top of the fire should be between (say) the fourth and fifth stay heads below the end of the arch for full power over some particular stretch of line when using some particular class of coal. The translation of test results into practical procedure is usually the most difficult step in applied research and is often a nice problem in industrial relations. This might well be so in the case under consideration, as Mr. Ell emphasised the need for ensuring that every part of the fire grate is making its full contribution to the rate of combustion of coal.

That this is desirable has been recognised ever since the steam locomotive first began to burn coal, but the precept is not always put into practice because it is often easier for the fireman to do something else that, although restricting the output of the locomotive is, nevertheless, adequate for the light locomotive duty that characterises practice in this country. It is quite common to feed the fire by lobbing coal on to a high mound from which live coal shakes, rolls or shuffles down to other parts of the grate under the influence of its slope and vibration. The firebox is thus made to contain a kind of internal hopper of coal in which the combustion rate is very low, but the light work demanded of the engine can be done with steam generated by burning of coal on other parts of the grate. Western Region practice goes further than this in keeping the fire black with fresh coal immediately adjacent to the firehole. This procedure seems to have been developed as a means for protecting the driver's legs from excessive heat where, as on the older engines, they were necessarily close to the firehole, for no leg shield is provided.

The habit of raising the firehole flap plate after the insertion of each shovelful of coal probably originated with the same object in mind, but this does improve performance by minimising the entry of excess air to the firebox. Sadly enough, the very assiduity of firemen in working the flap plate, despite its inconvenience, has discouraged any suggestion to use a firedoor that would have the same beneficial effect with much less manual labour.

A wicked imperfection in many British locomotives is that coal is delivered to the fireman at the front of the tender on a plate about a foot lower than the firehole, with the result that he must lift all the coal through this height. Avoidance of this defect by raising the shovelling plate has the disadvantage of reducing the possible limit of coal capacity of the tender unless a coal-pusher is

used. It is pleasant to record that, nevertheless, British Railways standard locomotives are well arranged in this respect. Not every fireman's reaction to the innovation is immediately favourable because it imposes a stance that may be unfamiliar, but the ultimate advantage is indisputable.

Observation of Footplate Work.—The fact that such an obvious and easy consideration for the fireman has been uncommon in this country is an example of the gap that lies between the designers and users of machines of many kinds. The case of enginemen is perhaps a special one as they work in such peculiar isolation that their normal operations cannot be closely watched. The presence of an observer on the footplate may modify the conditions appreciably and in fact there is no better example of the operation of Heisenberg's uncertainty principle which implies that nothing can be observed precisely and certainly because the mere taking of an observation affects the conditions. (In formulating this principle Heisenberg was thinking of relativity mechanics and sub-atomic physics rather than locomotives but he did regard it as universal.)

It is in general impossible to understand fully what is involved in any job without doing it oneself and this may explain why footplate needs have not always been fully taken into account by designers. A footplate rider may be unconsciously influenced by the normal interdepartmental spirit to decide that the enginemen can work quite well with what they have got and nothing different need be considered, or he may feel that his interests are best served by recording statistics to prove that the conditions are not so bad as they used to be, or he may be so affable to the men that they forget their woes, but it is unlikely that any of these conditions will give him a real grasp of the fundamental essentials. Discernment, understanding of basic physics, ability to get down to manual labour and experience of it for long enough to appreciate the difficulties but not to get used to them seems to be the rare combination of qualities required to translate operational needs into a specification for the designer ; this applies throughout mechanical engineering and nowhere more strongly than in connection with steam locomotives.

Working conditions on the footplate are emphasised here because the performance of a locomotive is entirely dependent on that of the fireman, and so observance of the fastest practicable schedules demands locomotives of good design in principle and in detail. A testing technique is required to determine the effect of changes in design and to that end tests may be run on a stationary plant or with a heavy train on a level, or gently graded road. The former does not reproduce road conditions exactly and the discrepancies may be significant ; the latter requires a special "path" in the ordinary train service and is limited in duration. Possibly the best solution is a prolonged run on a closed-circuit testing track with the L.M.S. type of mobile test unit to apply resistance variable in a manner that can simulate the conditions on any route whatever. The third scheme could completely test locomotives in the ordinary sense under constant resistance, but would alternatively permit of testing any proposed schedule on any route without necessarily going near it.

LAUNCH OF LIGHTSHIP.—We are informed that on Monday, October 11th, Light Vessel No. 17, "Seven Stones," was launched from the yard of Philip and Son, Ltd., Dartmouth, and is the twenty-fifth light vessel built by the company for the Corporation of Trinity House.

International Motor Show

No. I

THIS year's International Motor Show, the thirty-ninth of its kind arranged by the Society of Motor Manufacturers and Traders, was officially opened last Wednesday, October 20th, by Field Marshal Viscount Montgomery and once more the Earls Court Exhibition Hall at London becomes the focal point of interest for all concerned with the motor industry. It affords also an unequalled opportunity for the general public as well as for the expert to compare, under ideal conditions of presentation, the respective merits of the many vehicles sent from home and overseas.

Of the sixty-four motor manufacturers showing their latest products, thirty-two are British, with a total of 185 exhibited cars ; the remaining thirty-two firms are from overseas, with a display of ninety-six models from U.S.A., Canada, France, Germany, Italy and, for the first time after the war, with one exhibit from Czechoslovakia. Lack of floor space this year has prevented the organisers from granting facilities to manufacturers of specialised cars to present in a special display such models which have given outstanding performance in racing events during the current season. Some manufacturers, however, are showing at their stands certain non-production models which have gained fame in major international competitions, among them the Austin-Healey modified production type "100," which recently attained a speed of 192·6 m.p.h. at Bonneville Salt Flats, Utah (U.S.A.), and the Frazer-Nash 2 litre "Le Mans" model, the best British car in the 1954 International Alpine Trials.

In view of the international character of the motor show it is almost impossible to discern one general trend which would indicate the direction in which automobile development all over the world is likely to progress. On the contrary, this year's show seems to emphasise more than ever before the fundamental differences which exist between the British school of thought and that of America and the European continent. The American trend in motor-car design can easily be defined by such items as bodywork of more than generous proportions, big six-cylinder in-line or eight-cylinder "vee" engines, fully automatic transmissions and the retention of conventional rear axle arrangements. It is more difficult to define the Continental trend ; there remain wide divergencies of opinion among the individual manufacturers concerning both the most suitable general layout as well as such detail designs as suspension systems and engine and drive arrangements.

Between these two differing schools of automobile engineering, the British motor industry still maintains its position as representative of that general tendency which—in lieu of any better definition—is frequently styled as the orthodox or conventional design. American as well as Continental influence, of course, has left its impression on the design of the British post-war car ; it registered in such developments as the integral body-cum-chassis construction, the independent front wheel suspension and the synchronised gearbox. Nevertheless, the general mechanical layout of the modern British car differs from that of its predecessor not so much in its overall conception as in the greatly improved detail design of major components and accessories. It is a policy which confirms the strong belief prevailing in the British motor industry that substantial progress can be achieved better and more economically by evolutionary development than by drastic innovations.

Assuming the validity of these assumptions

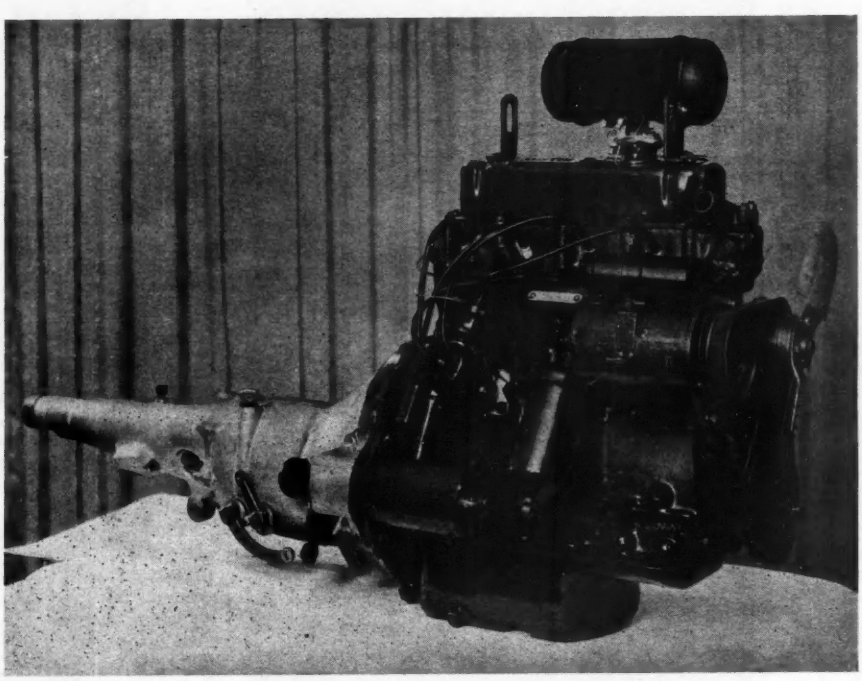


Fig. 1—Standard engine of British Motor Corporation for 1·2 and 1·5-litre cars of Austin and Morris

INTERNATIONAL MOTOR SHOW AT EARLS COURT

Fig. 2—Morris " Cowley " with a 1200 c.c. o.h.v. engine developing 40 b.h.p. at 4500 r.p.m.

Fig. 3—Austin " Cambridge " saloon with either a 1·2 or 1·5-litre engine

Fig. 4—Vauxhall " Cresta " saloon

Fig. 5—Standard " Ten " estate car

one should neither be surprised nor unduly perturbed by the fact that fewer entirely new cars are exhibited this year and that no startling or revolutionary changes in design are apparent. Excellence in design is not sufficient in itself to stimulate sales, unless backed by economic and competitive production methods, and it would be wrong to dismiss the conventional in favour of the new so long as the former is likely to remain a marketable proposition. The very fact that British car exports greatly exceed not only the combined effort of all Continental competitors but also that of America, conclusively proves that our cars are acceptable all over the world irrespective of operating conditions. In these circumstances the industry can make out a good case for not indulging in bold experiments when there is neither the technical necessity nor the sales incentive for any drastic change in design practice.

We mentioned before that foreign design principles have not influenced the mechanical layout of the British car to any great extent. On the other hand, the show clearly indicates the impact which the American body style has left on the shape and structure of British bodywork. Most British manufacturers have now adopted this style which, since its first introduction some years back by firms associated with the two big American concerns, Ford and General Motors, has been accepted by the public with little reservation. There are, of course, still sentimentalists who deplore the disappearance of such adornments as dummy radiators, but as a whole the public, or at least the prospective buyers of medium-priced cars, have learnt to appreciate the real practical value and the æsthetic appeal of the modern body style. Several good examples of styling among the popular mass-produced cars illustrate the improvements made during the past year : the air-intake grille has become wider, lower and more restrained in its ornamental treatment, the driver's vision has been improved by increasing the forward slope of the bonnet, and chromium-plated strips are more used nowadays for concealing joints than for purely ornamental reasons. An additional feature, not entirely novel but being more prominent at this year's show, is the raising of the rear wheel crowns which, because of its influence on the aero-dynamic behaviour of the car, improves the handling characteristics ; it also gives the stylist an opportunity to prove his skill in arranging that vast array of rear lamps, reflectors and flashing indicators which adorn the tail end of a modern car. Add to this collection of useful details a general improvement in the trim and finish of the seats, in the arrangement of the pedals, brake and gearshift levers, and in the grouping of instruments (among which the cooling water thermometer is becoming more and more popular), fully states one of two tendencies which, we believe, impress the visitor in the British sector of the show.

Whereas the first trend, namely, the conventional mechanical layout with considerable improvements in body shape and construction, is chiefly a matter of design and engineering skill, the second trend has wider implications and involves a marked deviation from the orthodox marketing policy of some British manufacturers. For some time it has been realised that the aim of maintaining hard-gained advantages on overseas markets will depend, first of all, on checking any further rise of production costs and that substantial benefits are to be derived from stricter standardisation and concentration on fewer models from any one factory. Following the example of Ford and Vauxhall, which have been employing this policy for some time, more manufacturers are now concentrating their main effort on producing only one or two basic chassis or bodies, together with two or three alternative engines which, though different in cylinder capacity, are similar in their general layout and contain a great number of interchangeable parts. By further supplementing their range by so-called " luxury " models, differing from the standard versions mainly by some additional equipment, better finish and more elaborate ornament, they are able to offer at a reasonable price a greater variety of choice.

The method of marketing two or even three models, based on one standard chassis with alternative engines of different size and output, compels the designer either to compromise or to enhance one particular version at the disadvantage of another. No difficulties, however, have so far originated on that account, and cars constructed on this basis have generally proved quite satisfactory. The economic advantages of this method, which not only reduces the cost of production, but also simplifies service operations and the stocking of spare parts, are so apparent that its increasing acceptance, evident this year, causes no surprise.

Since the formation of the British Motor Corporation in November, 1951, there has been a certain amount of speculation whether or not this merger of the Austin and Nuffield groups of companies would result in some reduction of the considerable number of individual models made by the various factories of the Corporation. So far, this expectation has not materialised, but a start towards greater simplification of the manufacturing process has been made by standardising the design of engines and other major components made by the Corporation. This process of interchanging major components between Austin and Morris cars began actually two years ago, when the 1-litre side-valve engine of the Morris " Minor " was replaced by the greatly superior 800 c.c. o.h.v. engine of the Austin " A 30." The next step in 1953 was a new 1·5-litre engine of 89mm stroke and 73mm bore for the M.G. " Magnette," a design which was based on that of the well-tried Austin " A 40 " engine, and which has now been adopted as the power unit for the Morris " Oxford " Series II and for the Austin " A 50 " (Fig. 1). The latest addition to this range is a 1·2-litre engine of the same stroke, but of slightly smaller bore (65mm) than the 1·5-litre engine. It is in every respect, apart from the different cylinder and piston size and the smaller diameter of the flywheel, identical with the latter and forms the power unit of the Morris " Cowley " and the new Austin " A 40." In order to comply with the traditional custom of the individual firms, the engines of the Austin cars are fitted with Zenith carburetters, while those of Morris and M.G. have S.U. carburetters.

It is obvious that the use of engines which differ in their cylinder capacity and output by only 25 per cent instead of 50 per cent, as is the case when alternatively four and six-cylinder engines are employed in a car of basically similar weight, does not alter the performance and handling characteristics to any great extent. On the other hand, this method constitutes a valuable sales point, as it doubles the number of apparently different models available to the customer without interfering noticeably with the cost and flow of production. Whether the public will prefer the better performance of the bigger or the slightly lower fuel consumption of the smaller engine, remains to be seen. Unless customers show, as we are inclined to believe, a marked preference towards engines of greater cylinder capacity, there is no reason why both sizes should not be built simultaneously for some time to come.

After this general survey of the principal trends in the industry, we turn to a description of some of the latest British models and of such foreign cars which are either displayed in this country for the first time or differ from their British counterparts in general layout and detail design.

At the stand of Morris Motors, Ltd., the new " Oxford " (Series II) is the centre of attraction. Introduced last May, the car is a full six-seater of integral construction and differs from its predecessor mainly in having greater roominess, better appearance and improved performance. Many of the well-known technical features of the old model have been maintained—for instance, the steering-column-controlled four-speed gearbox, the hypoid rear axle drive, the rack-and-pinion steering and the torsion bar front suspension. The old side-valve engine—as has already been mentioned—has been replaced by the modern 1·5-litre B.M.C. standard engine, with the result that the new model, in spite of its enlarged bodywork dimensions, greatly excels the performance characteristics of its predecessor in respect of maximum speed, acceleration and fuel economy. Other new items which increase the overall usefulness of the car include a hydraulically operated clutch, a rear-mounted electric fuel pump and an air scoop on the top of the bonnet through which only clean air can enter the heating and ventilating unit. The " Oxford " weighs about 22 cwt and as the engine has a maximum output of 50 b.h.p. the power-to-weight ratio of about 45 b.h.p. per ton should be sufficient to ensure reasonable top-gear performance even when fully loaded.

The new Morris " Cowley " in many respects is identical with the " Oxford," but is less elaborately finished and equipped (such items as heater, second visor, overriders being optional " extras "), and is fitted with the smaller 1·2-litre, 40 b.h.p. version of the B.M.C. standard engine (Fig. 2). The " Cowley " can be regarded as an austerity model of the " Oxford," and is apparently designed for customers who desire the amenities of a roomy family saloon, but are prepared to contend with a certain loss of maximum speed and top-gear flexibility for the sake of lower first cost and slightly reduced fuel consumption.

The main interest at the stand of the Austin Motor Company is concentrated on the presentation of the new " Cambridge " saloon, a car designed to replace the " A 40," which, since its introduction in 1947, has been built in large quantities and has become one of the most popular British cars at home and abroad. The " Cambridge " is available in two versions, fitted either with the 1·2-litre engine (" A 40 ") or with the 1·5-litre engine (" A 50 ") (Fig. 3). The two models are identical and differ only in cylinder capacity and axle ratio ; both are available in either two-door or four-door form, with either standard or de luxe equipment.

The introduction on the market of a new Austin is always a major event for British motorists, and a great deal is expected from a car which has to carry on the reputation established by the " Devon " and " Somerset " by their good all-round performance and reliability. For some time it had been clear that the previous " A 40 " models, the basic conception of which dates back some ten years, no longer conformed

with present ideas of modern body styling and that the whole design had to be reconsidered with a view to bringing it entirely up to date. The new "Cambridge" is a full-width, modern-styled, four-seater saloon of integral construction which combines sufficient roominess and ample luggage accommodation with a definitely pleasing appearance. Compared with its immediate predecessor, the "Somerset," it is 2¾in longer, but lower and slimmer; in spite of the reduction in overall width and height, it is considerably roomier inside than the "Somerset" and, having an increase in wheel base of 6¾in, the rear seats could be positioned forward of the wheel arches, thus allowing three passengers to be accommodated when occasion demands.

The all-steel, stressed-skin body, like that of the "A 30," is notable for its absence of soldered joints. It differs, however, from that of the "A 30" by the incorporation in the body structure of a rudimentary chassis, consisting of two longitudinal box-shaped members which carry the engine and gearbox mountings, the brackets for the rear springs and the jack points. The detachable cross member at the front which carries the independent front wheel suspension of well-proven conventional design, is rubber-insulated relative to the body for the purpose of damping the road-excited noise. Long semi-elliptic reverse-camber springs, underslung and mounted on rubber bushes, carry the pressed steel banjo rear axle, which contains a hypoid bevel drive. Double-acting piston dampers are fitted at the front and at the rear, the latter being interconnected by a stabilising bar. The four-speed gearbox is an entirely new component and is equipped with baulk rings instead of the constant-load synchronisers previously used, and the gear-change linkage has been improved to make the action both smooth and instantaneous. Among the other numerous improvements we mention only the hydraulic operation of the clutch and the location, underneath the luggage boot floor, of the spare wheel in a cradle which can be lowered by means of the starting handle. An air scoop at the tip of the bonnet leads the air through a duct at the underside of the bonnet to the heater and fresh-air system, thus obviating the long ducts which take up an appreciable space in the engine compartment (Fig. 6). The engine is basically similar to the well-known power unit of the "A 40," though the running gear is suitably strengthened to cope with the higher stresses of the 1·5-litre version. Both engines have the same compression ratio of 7·2 : 1 and the same overall dimensions, so that either version fits into the standard chassis of the "Cambridge." The smaller engine develops 40 b.h.p. at 4500 r.p.m., the bigger 50 b.h.p. at 4400 r.p.m., and both have their maximum b.m.e.p. of about 120 lb per square inch between 2100 and 2300 r.p.m. Useful modifications include a Hobourn Eaton double-rotor oil pump and the fitting of four piston rings instead of the three rings previously fitted.

It is evident from the preceding description that the "Cambridge" in every respect is an entirely conventional car, devoid of anything which could be regarded as revolutionary or even particularly novel. This might disappoint the ardent student of automobile engineering, but it is and has always been the policy of the Austin company to adopt new technical ideas only after they have proved their actual value after extensive road tests. There is little doubt that this cautious attitude, which benefits the customer, is one of the main reasons for the reputation of Austin as manufacturers of the "dependable" car, and it is unlikely that the "Cambridge" will share the fate of some other makes marketed during the last few years, which, though impressive in conception, fell rather short of the performance displayed by the first prototype, once they got into actual production.

Turning now to the stands of the other "big five," we note that the range of cars displayed by the Ford Motor Company, Ltd., continues basically unchanged; modifications are almost entirely confined to interior details and minor refinements. Interest seems to centre round the new "Anglia" and "Prefect" cars which, after their introduction at last year's show, have established a reputation for lively performance, and are frequently acclaimed as the best-styled models among the large international group of small cars.

Vauxhall Motors, Ltd., introduces a new de-luxe model, the "Cresta," with a basic specification similar to that of the six-cylinder "Velox" (Fig. 4). It is fitted as standard equipment with such items as leather upholstery, two-colour paint finish, white-wall tyres, foam rubber seat overlay, &c. Apart from this new addition to the range of Vauxhall cars, a number of modifications have resulted in a marked change of appearance between the 1955 Vauxhalls and the previous models. The bonnet is wider and lower, improving both the look of the car and the forward driving vision. The radiator grille is also wider, lower and more restrained, and the bumpers and over-riders are deeper and more substantial. The "Velox" and the "Cresta" are improved in side view by rear wheel cover panels and new hub caps, and a chromium-plated belt line forms a natural dividing line for the two-colour paint schemes available on the "Cresta." The steering column and the gearshift mechanism are now enclosed in a tubular casing.

The choice of either 6·5 : 1 or 7·3 : 1 compression ratio, available for some time on "Velox" engines, is now extended to the "Wyvern." With this new compression ratio the maximum brake horsepower of the "Wyvern" is increased to 47·7 b.h.p. at 4000 r.p.m., an increase of approximately 5 per cent on the previous standard engine. Cylinder wear has been reduced by a new piston ring assembly of greater contact pressure, the upper ring now being chromium-plated.

Another interesting modification concerns the steering layout: the former assembly of steering column and box is replaced by two separate, rigidly mounted units—the column assembly and the steering gearbox; the two units are connected by a flexible coupling which absorbs road shocks and effectively cushions the steering.

The Standard Motor Company, Ltd., this year introduces on the home market the Standard "Ten," which for some time was sold as an export model only. The car is almost identical with the de-luxe version of the Standard "Eight," but has a bigger engine and, consequently, a higher rear axle ratio than the latter. The push-rod-operated o.h.v., four-cylinder engine, of 948 c.c. capacity also, is similar to that of the Standard "Eight," having the same stroke (76mm), but a bigger bore (63mm) and develops 33 b.h.p. at 4500 r.p.m., with a maximum torque of 550 lb-in at 2500 r.p.m. Unlike the Standard "Eight," which was first introduced at last year's show, the new "Ten" has a luggage boot which is accessible from the outside, winding windows with hinged ventilators and interior door panels.

A new estate car, based on the design of the "Ten" has a six-light, steel-panelled body, four forward hinged passenger doors, and two further doors at the rear, giving access to the luggage compartment (Figs. 5 and 7).

[Fig. 6—Engine and gearbox of the Austin "Cambridge," showing air duct and intake of heater and de-mister unit

Fig. 7—Standard "Ten" estate car with rear seat lowered to give extended platform

The front seats are separate and adjustable, while those at the rear are of the divan type; the rear seat squab folds flat and level with the luggage platform and is secured in its upright position by catches. The spare wheel and the tools are housed in a separate compartment below the luggage platform. With two people on the front seats and the rear seat folded, the car is capable of carrying 4 cwt for a dry weight of only 15·2 cwt.

Another estate car, developed by the Rootes Group, is displayed at the stand of the Hillman Motor Car Company. The new model, known as the "Husky," is of integral construction and, like the Standard dual-purpose car, combines the amenities of a saloon car with those of a small van. It has two doors at the front and one at the rear, giving access to the luggage compartment. The luggage platform can be extended to carry 5 cwt by tipping the rear bench seat forward so that the back of the seat occupies a vertical position behind the separate front seats. The rear of the seat back then swings down to a horizontal position, forming a continuation of the platform. The mechanical layout of the "Husky" is based on that of the Hillman "Minx," using the same components for suspension, steering, engine and transmission, with the exception that the gearbox is not equipped with steering-column control, but fitted with a central gear-shift lever. The wheelbase of the "Husky" is 9in shorter than that of the "Minx." It weighs dry less than 17 cwt, has the useful power-to-weight ratio of 41 b.h.p. per ton, and, accordingly, should give a lively performance. The standard 1·2-litre Hillman "Minx" saloon remains basically unchanged, but the *de luxe* saloon, the "Minx Convertible" and the "Californian," are now fitted with a new 1·4-litre o.h.v. engine. These cars, with an increased rear axle ratio, are said to be capable now of a maximum speed of 75 m.p.h.

The new four-cylinder engine of 76·2mm stroke and 76·2mm bore has a capacity of 1·39 litre and develops 43 b.h.p. at 4400 r.p.m. Separate inlet and exhaust ports improve the fuel distribution, and a thermostatically controlled "hot spot" in the inlet manifold ensures easy starting.

The estate car is a practical and attractive dual-purpose vehicle, and its popularity seems assured.

(*To be continued*)

Research in Mechanical Engineering

By R. W. BAILEY, D.Sc. (Eng.), Wh.Sc., F.R.S.

In his presidential address to the Institution of Mechanical engineers last Friday, here reprinted almost in full, Dr. R. W. Bailey discussed several facets of research, touching upon organisation for research, the respective merits of individual effort by firms and co-operative effort in research associations, utilisation of results, education and the part played by the Institution.

THE most important element in a research organisation, as in an engineering undertaking, is the staff and its quality, particularly those members who are responsible for, and able to think a stage ahead of, current practice. The Council of the Institution recognises the valuable experience and training gained through a period of service in a research department, and take this into account when considering applications for membership. Buildings and equipment are secondary, provided they can serve essential needs, and one of these is that they should not only be adequate, but be situated to ensure full effectiveness. But much economy in cost, and an accompanying increase in the fruitfulness of the work undertaken, results from purposeful thinking beforehand to perceive and grasp essentials so that the risk of misdirected or wasteful effort is reduced to a minimum, and the promise of vital information and service is high. Whether the staff is large or small in number, it should be inspired and actuated by the principle that its purpose and business is to contribute to the engineering progress of its employing firm or organisation, not merely to find solutions to isolated problems or questions put to it, but to take a much wider interest, and to see a problem or a number of problems in their engineering setting, remembering that an 80 or 90 per cent solution, obtained expeditiously, is often of more value, both in immediate result and as a contribution to fuller understanding later, than a prolonged striving for a 100 per cent solution. Engineering problems generally involve so many factors, often entering as variables whose influences may interact, that frequently it is more profitable to know what the factors are and to assess their relative significance, than to incur serious delay in striving for unessential refinement in dealing with any one factor. This often requires the exercise of judgment based upon engineering considerations, and points to the importance of training of the principal staff in the principles of mechanical engineering sciences and knowledge, including design. Also, a good knowledge of workshop processes should be possessed. Such breadth of knowledge and versatility should be aimed at to allow intelligent understanding of, and participation in, the problems which are bound to arise in the engineering development and running of plant, including investigation of failures, which is so rewarding in knowledge and vital experience.

The strength and properties of engineering materials, including the laws governing their behaviour, both elastic and plastic, now enter so much into questions of design and endurance of parts, that this field of knowledge should be reliably and, in necessary directions, authoritatively covered by the staff available. It will be evident that the character of training and experience desired in the staff considered by this address would be basically that in mechanical engineering. But a criticism can be made of the usual product of training courses which it would be an advantage to rectify, namely, that the metallurgical knowledge of young engineers is much less than it should be. It can also be said with equal force that the usual product of training in metallurgy is, from an engineering standpoint, deficient in knowledge of the mechanical properties of metals and the laws and theory governing their behaviour under stress. It would be less difficult, we believe, however, for one with the usual training in mechanical engineering to acquire sufficient metallurgical knowledge, than for a metallurgist to rectify the deficiency of knowledge of the behaviour of metals under stress and, consequently, the addition of desirable metallurgical knowledge would not affect the basically mechanical engineering character of the staff training desirable.

It is fortunate, therefore, that the normal technical and scientific training of mechanical engineers, which demands and cultivates logical thought and continual reference to experiment, is conducive to versatility in the acquirement of knowledge in other fields, and that the practice of engineering, especially in the matter of design, which encourages a sense of responsibility in making decisions concerning these fields of knowledge, is adapted to develop the type of staff that would be sought for a mechanical engineering research organisation. Thus, most mechanical engineering firms and undertakings of any size and advancement are initially in a favourable position to create an effective research staff given the desire to do so, and also to provide the individual to lead this staff. Primarily he should be an able mechanical engineer, having considerable knowledge and keen interest in the science of engineering, and in engineering development.

But before a research undertaking is embarked upon, or research activities engaged in, consideration would need to be given to the question of policy. This generally would depend largely upon the size of the firm and the nature and variety of its manufacturing interests. As with other factors which contribute to engineering costs, optimum advantage in benefit would be sought for the expenditure incurred. This, however, is not the same as the minimum cost for a given activity, because benefits are often intangible in character and difficult to assess in terms of money cost—for example, the time taken to reach a result and the range of usefulness of the result. The former, although it might be expressed specifically as a period, or in man-hours, would convey no idea by itself of the greater value that would attend a shorter time. The latter would be even more difficult to estimate. The time would, of course, enter as a factor but not so much on the basis of cost per hour, but upon the value to be assigned to prior arrival at the result, and the advantages that would flow from this priority. Then, again, if the research were undertaken by an external agency, for example, a university or an industrial research association—the inspiration, stimulus and knowledge acquired on the way, would not be the same, other things being equal, as if the research were conducted by the firm's own organisation. (No implication is involved here of one course being superior to the other, or the reverse, since different individuals would be concerned.) Sufficient has been said to indicate that research should not be judged upon money cost of a specific activity and that other considerations may be, and generally are, overriding. Fundamental in affecting staff considerations, and indeed also equipment and facilities, is the policy regarding the principle upon which a firm's interest in research is built, that is, principle (1) individual effort, principle (2) external aid, or an association of both.

In spite of its insufficiency as a basis for critical judgment, money cost would often be taken as the first measure of the cost of research upon a chosen principle.

The cost involved by research on principle (1) would be higher than that on principle (2). Generally, however, the former would constitute the major research activity of the larger firms and those who have very

special interests, and the latter would be attractive to the smaller non-highly specialist firms and as an auxiliary in the case of the larger firms concerned with pioneer development, either to deal with subjects which are not of first importance and which would relieve and set free their own staffs to give attention to matters of high importance to themselves, or to have the advantage of expensive testing equipment of limited though vital application which might already be available.

In all cases the return on the expenditure will be greatest, and the results most satisfactory, the higher is the real technical quality of the staff engaged by the firm receiving the benefit. This will be evident in the case of principle (1) when the interests of the firm are concerned with pioneer developments, but it will be no less so in the case of principle (2) and of the smaller firms who might rely almost wholly on external research. Their need is to extract the utmost in essential information from the work and reports from other sources, for example, technical literature and industrial research associations, not merely noting results but by hard thinking and reasoning upon the evidence, questioning everywhere any lack of clarity and dubious interpretation of evidence so that a more comprehensive and critical view of the subject would be gained, than perhaps might have been held even by those responsible for doing the work. Thereby weakness of evidence and deduction would perhaps be disclosed and the need for further investigation, as well as its character, made apparent. Representation to the research association of a well-founded case for additional investigation would not go unheeded and, if it did, those responsible for pointing out the need would be in the foremost position to concentrate effort on a subject of perhaps vital significance. Emphasis should be laid here upon the value of a clear understanding of the physical basis of the phenomenon involved, in aiding a critical view of the evidence. If speculation and deductions were confirmed by test, the range of interpretation and value of the data would be increased and, even if this were not so, progress would have been hastened by discovering the reason. By these means the fruits of research may be had at a comparatively low cost, but the possession of a vigilant, highly capable staff member, or members, responsible for the firm's external research interests, is essential for the fruit to be gathered.

A question of considerable interest and importance is to what extent may principle (2) be combined with principle (1) to secure most advantage. This cannot be answered, however, without recognising the extent to which different features commonly characterise research according to each of the principles. These features may be considered as falling under the following headings :—

(*a*) Direction, (*b*) experimental resources (*c*) staff, (*d*) contact with engineering needs, (*e*) utilisation of results in development.

(*a*) *Direction.*—(1) By individuals, who are frequently experts in their particular fields ; (2) by committee ; committee members may have more diverse interests than in a particular field and committee policy and decision may be less informed than its more expert members.

(*b*) *Experimental Resources.*—(1) May vary widely with firms ; (2) may vary widely, but can be of the highest standard.

(*c*) *Staff.*—(1) Can vary considerably in quality and standard ; (2) can vary considerably in quality, standard and capabilities.

(*d*) *Contact with Engineering Needs.*—(1) Close, but may be of variable intimacy ; (2) less close than (1) and intimacy variable.

(*e*) *Utilisation of Results in Development.*—(1) Most direct ; (2) less direct and may well be more delayed than (1).

(*a*) *Direction.*—Important differences may flow from the two types of direction. The rate of progress and speed of action is usually greater with principle (1) than (2). In both cases a programme is necessary, but modification of the programme or line of attack may be shown to be desirable as the work proceeds ; moreover, exploration along other avenues may be seen to be needed, or to offer promise, and the greater flexibility and higher speed of action usually possible under (1) than where committees are concerned, as with (2), are important advantages. Also, the writing of reports by staff for committees may interrupt progress and cause delay when on-the-spot consideration and a decision might suffice under (1).

(*b*) *Experimental Resources.*—There would be little to choose between the two principles in the case of firms having well-developed research organisations, except in the case, already referred to, of special and expensive equipment or facilities possessed under principle (2), which it would be uneconomic in cost and use to have multiplied by firms. For firms able to justify only moderate expenditure upon research the advantage would definitely be with principle (2).

(*c*) *Staff.*—The quality of the leading staff employed, those relied upon to think and act imaginatively, as already stated, is the most important asset of a research organisation. Success in building up a suitable staff is largely dependent upon attracting or selecting persons possessing the qualifications and qualities needed. The larger and more advanced engineering firms and better-known industrial research associations would possess greater attraction to candidates than the smaller firms and less well-known research associations and, to this extent, they would be in an advantageous position, but the smaller firms should not overrate these adverse circumstances, which might be more than offset by the remuneration and prospects which would be promised or would eventually accrue to the right type of candidate.

(*d*) *Contact with Engineering Needs.*—This contact should normally be closest and most effective in the case of principle (1), but its cultivation is essential in both principles and the closest relations between research and engineering personnel should continually be striven for. Mutual confidence and respect for the technical capabilities of one by the other would be aided by their largely common basic scientific training.

Brief mention was made earlier of the importance of the situation chosen for a research laboratory as a factor essential to the full effectiveness of the research undertaken. In view of the bearing of this factor upon contact with engineering needs and as it has significance in both principles, it may well be given consideration. Of the two principles, the advantage of a much greater definiteness of choice is with principle (1), since usually the local conditions of a firm would dominate the choice, but with (2) the most suitable site of a research association's organisation should take into account the density and geographical spread of the industry it has to serve and the facilities for travel and communication between member firms and the organisation.

Considering principle (1)—that is, research by a firm—the advantages both to the research activity itself and to the firm's engineering needs, gained by the close proximity in space and ready discussion between members of the research and engineering staffs, are mutually so considerable that, where it is practicable, location of the research laboratories at the works is the choice that would be favoured. The barrier influence of separation by even 1 mile, especially if it is uphill and car parking is inconvenient, can be significant, particularly if live interest from either side lags, or has been allowed to become blunted.

In the case of principle (2), once the location of the research organisation is determined, there is little that could be done about it by the member firms of an association, and by the association, except through their organisations to improve the intimacy of their interests. This, however, would be a highly important endeavour, and the suggestion, made earlier, of making a well-qualified and competent member of the firm's staff responsible for the firm obtaining the full benefit of the association's research would be an essential step in this direction which would be profitable to both the firm and the association.

(*e*) *Utilisation of Results in Development.*—The more intimate association of engineering with research in the case of principle (1) than would normally be found with (2), would usually result in a more rapid utilisation of results in current development. Indeed, it is probable that the character of the work, or its direction, would have been influenced at its inception by specific engineering needs, more in the case of (1) than of (2), and this alone would aid early utilisation.

To sum up this theme, substantial advantages would normally accrue to a large, technically active and progressive firm conducting its research on principle (1). There might be no case for principle (2), except as auxiliary to (1), where, however, it could provide valuable service, of which full advantage should be taken, and its cost should not be regarded only as of the nature of an insurance charge safeguarding against surprise developments.

Outside this use the natural case for principle (2) would be that of the smaller firms and firms possessing smaller technical resources. Its several handicaps compared with (1) can be important, but, being recognised, measures can be taken to lessen their significance and, as already indicated, to confine research individually undertaken within limits to matters of particular value to the firm, full use being made of the results of the more general research conducted co-operatively by an industrial research association.

It is possible in the case of a firm operating principle (1) that doubts may arise whether the expense of principle (2) could really be justified in addition. The removal of doubt, should it occur, would depend upon the extent to which the cost of principle (1) could be relieved by reliance upon (2) to carry research which would otherwise burden its own facilities for carrying out work more vital to itself. Assuming equal efficiency in carrying out a given piece of research, lower cost would be expected in the case of an industrial research association, because of the contribution to the income of the association made by State grant ; the whole cost, therefore, would not be expected to fall upon the contributing firms. But this would not be a complete picture, because the call for research made by a subscriber upon an association, or the use made of an association, would vary widely—that is, from nil to as much as could be laid upon it. It is possible that a large industrial concern conducting its own highly developed research

organisation might make little or no demand upon a research association, although in fact it might be making contributions to several, not only by direct payment, but also by the assistance given by members of its staff where they happened to sit upon technical committees of the associations. In this case there would be little return upon the outlay. On the other hand, in the extreme case where maximum use is made of an association, particularly the case of a firm operating only principle (2) with full demand upon the association, a highly gratifying return for the expenditure incurred by a firm in this category (smaller firms) should be obtained for what, in effect, would be heavily subsidised research—that is, by State grant and contributions by firms making little or no demand upon an association and perhaps, at the same time, providing useful technical aid. Another factor which may operate in favour of the smaller firms would be that the subscription of the larger and more wealthy firms might be numerically higher, because of assessment differences, than for the smaller and less wealthy ones. Should the former not make a commensurate use of the association the advantage to the smaller firms would be further increased. Indeed, a position might arise where a firm operating both principles and making little use of principle (2) might justifiably look to correspondingly favourable subscription terms compared with those applicable to a firm which by its nature and policy would make considerable use of that principle. For this to be reasonable, however, it should be clear that the circumstances were such that there was no failure on the part of the firm to make appropriate use of the service available to it. There is another side to this matter, namely, that the special needs of some members may entail costs for which the association could reasonably expect special assistance to be given by those members. In my own experience there has been no hesitation by the firms concerned in providing the needed assistance.

From what has been said it will be evident that the cost of research to a single firm can vary widely, depending upon which principle, or both, which characterises its policy. Likewise, the degree of benefit and satisfaction obtained can also vary considerably. As we have already indicated, whatever policy characterises a firm's interest in research the most important factor is the technical quality and capability of the staff employed, and nothing should be sacrificed to that. Moderate accommodation and the right man and staff would be more successful, profitable and less costly than imposing buildings, lavish equipment and a staff lacking in essential knowledge, understanding, energy and imagination, and not inspired by a feeling of personal responsibility for contributing a full part to the firm's technical advancement and engineering responsibilities.

The highest actual expenditure would be involved, of course, by principle (1), if it were increased by principle (2) as an auxiliary, and no advantage were taken of utilising its possible aid to relieve principle (1), and the lowest expenditure would occur with principle (2). These statements, however, are over-simplifications. The importance of making use of principle (2) to relieve (1) has already been indicated ; it is doubtful, however, in many cases, whether this has been given the consideration it deserves. Each case should be dealt with on its circumstances and merits, but, in a general way, it can be said that economy would be achieved where both principles were operated if (2) were utilised to the maximum extent to set free facilities in the case of (1), assuming there is vital work to be done under (1). Also, where the cost of (2) might be questioned as an extravagance, the correct approach should be first to inquire whether full use had been made of the possible aid from (2) and, if not, to leave the question until that had been done. In the case of the small firm without the resources to face the initial expenses of (1) the right principle would be (2), but, as implied above, with a suitably qualified staff member being made responsible for ensuring that the fullest use would be made of the aid to be obtained therefrom, by being able to discern the insufficiency of the information flowing from the association and to fill in the gaps or, by inquiry, by search of the literature, and by additional investigation, to satisfy the immediate needs of his firm. But, it should be remarked, reliance wholly on this policy might prove disappointing in not breaking much new ground unless, as a result of acute insight and by suggestion, action by others were stimulated. Otherwise, more rapid and effective progress would require resort to principle (1). Alternatively, something might be done to increase the efficacy and range of application of the particular research by a closer contact of the investigator with industrial needs. This might be obtained, on the initiative of those responsible for the research, by discussion of the results with engineers representative of the industry served. In effect, this may be claimed to be what happens when a report receives the scrutiny of its committee before issue. This, however, would not be quite the same as obtaining a concensus of the opinions, questions and needs of the user recipients of a report, to amplify interpretation of the results and to stimulate and guide further investigation. A closer association of user and those responsible for carrying out the research could hardly fail to increase interest on both sides and help to develop recognition, by the user, of the fact that he has an important part to play as partner, resulting in benefit to the user firm and service to the association, thus increasing its effectiveness. To adopt principle (2) with the belief that it is only necessary to subscribe and be at the receiving end to obtain the benefits of research, is likely to prove disappointing to the subscriber, and certainly to the association, and there is a fair chance of termination of membership as hardly worth while, whereas the fault may lie in the failure of the member to recognise the contribution he can make as an essential partner in the enterprise.

Interval Between Discovery and Application.—The long interval that sometimes has elapsed between a discovery and its application has often been remarked upon. (A good example of this was furnished by the discovery by Joule, as early as 1855, of the electric welding and melting of metals and the electric melting of iron.) A similar situation may arise in the case of the results of research and their use or exploitation, and such happening has to be guarded against. There is less risk of this delay with principle (1) than with (2), because with the former the need for application is likely to be immediate, and this fact, in many cases, would have been responsible for initiation of the work. This circumstance gives point to my earlier remark as to the value of reaching an 80 or 90 per cent solution expeditiously rather than striving for a 100 per cent solution later by prolonged effort, although the circumstances of the case would, of course, indicate whether the 100 per cent should continue to be regarded as a profitable and desirable goal.

Having suggested that it is extremely doubtful whether in many cases full advantage is taken by engineering firms of the service of research associations because it has not been the responsibility of a suitably qualified member (or members) of the staff to examine critically, and assess or suggest the application, in that firm's own case, of information flowing in from the association and other sources of scientific and technical information, the question of the supply of the grade of individual needed is almost certain to be raised. The fact that a member of the staff had this responsibility would bring about not only much closer knowledge of the work of the association, but also of the particular interests and capabilities of members of its staff. In addition to the relations between the association and the firms thus becoming more intimate, opportunities would probably occur from time to time for engagement by the firm of a member of the association's staff possessing industrial leanings and promise, which eventually should be beneficial to both sides, within the limitation that the movement would not be detrimental in weakening the association's organisation. Also, a similar question arises in connection with my reference to the long interval that has frequently occurred between discovery and application of new knowledge, namely, shortage of suitable personnel—a problem rendered more difficult now for industry by the demands of service departments for scientific and technical staffs, and by the nationalised industries. This brings me to the part which education and training can play in helping to create the numbers and quality of the manpower required.

As long ago as 1945 the Percy Committee stated that " the evidence submitted to us concurs in the general view : first, that the position of Great Britain as a leading industrial nation is being endangered by a failure to secure the fullest possible application of science to industry ; and second, that this failure is partly due to deficiencies in education. . . . In particular, the experience of war has shown that the greatest deficiency in British industry is the shortage of scientists and technologists who can also administer and organise, and can apply the results of research to development."

I think that no one of standing with an intimate knowledge of technical education and industry has ever denied the truth of that statement, and certainly many of the reports of the Anglo-American Productivity Council teams that have visited the United States have stressed the need for men adequately trained to apply research to development. This, I feel, points to the problem to be faced, but without suggesting its remedy, except perhaps by implication, that is, by increasing the number of entrants and by multiplying the facilities for training.

Probably all engineers from Britain visiting the United States during the last thirty years or so have been impressed by the disparity in the numbers of engineers and technologists who can be and are devoted to a corresponding development in the two countries. On the other hand, they have generally found that the quality, breadth and versatility of the product of our training courses, in the more responsible positions, is not inferior to that found in the United States. At any rate, judged by Britain's record in the field of invention and engineering development there is not anything seriously wrong with our training nor with our native capabilities, and little more than expansion on established lines appears to be demanded for the training of professional engineers.

On the evidence, there seem to be two

essential matters to which our educationists, and we as a profession and industry, have to devote attention. One is to increase the supply of alert-minded, able and well-trained young men to provide numbers which at present are lacking and whose absence has been the subject of repeated comment and complaint, and the other is to provide the very best facilities, both scientific and technological, to assist the comparatively small numbers fitted by abilities and capacity to become the creators and leaders of the future. The more pressing need appears to to be the former.

But there is no need to be depressed over the advantage in numbers enjoyed by the United States. This is a fundamental difference which may be expected to increase if it is not countered by a radical change here, because our problem, as with many other of our difficulties, has its roots first in manpower shortage, and, secondly, in the need for improved training facilities. It should be widely recognised that we have to use our resources of manpower and natural abilities more completely and efficiently. We have to increase numbers at the levels at which our needs are most felt and to provide training facilities that will ensure the best development of the knowledge and qualities required in the people trained.

Consideration of the problem as a whole, which is one in which all three parties, the profession, industry and the Ministry of Education have vital interests, would be an important first step towards meeting and solving the problem of expanding our professional and technical manpower, and in raising its standard. The councils of the three major engineering institutions are keenly interested in the matter of higher technological education and have, over the years, not only been in close consultation with the Minister of Education and with the National Advisory Council for Higher Technological Education and also with other bodies concerned with this problem, but also have submitted memoranda to the Minister as to their proposals for the improvement of the general status and standard of education in a limited number of colleges of technology. Much attention and thought must have been given by different interests and authorities and I feel very strongly that the time has come for something to be done, and for the Government to give a lead in setting in motion plans to expand and improve our training facilities where the need is most felt and urgent.

Before leaving the present subject I would remark upon our neglect of an important source of manpower which is insufficiently utilised. Considerable attention is given by the industry to craft training through its works' training schools, but, beyond this, little is done systematically to take advantage of the wonderful opportunity thus afforded by the large mass of human material under observation and instruction to detect, select and encourage to pass on by training and further experience to greater opportunities and to more valuable occupations, those fitted by ability and characteristics for advancement in the profession. This would be doing purposefully what has happened in the past mainly fortuitously in the case of the more energetic and able young men, who, often by a considerable sacrifice of leisure and by sustained effort, have worked their way upwards.

In the past, this channel has provided many capable engineers who have held positions of all degrees of responsibility and, as we know, are doing so to-day. The race, however, was to the able and physically sound, but the wastage caused through indiscriminate admission by those who fell by the way, tired and disheartened, has been very great indeed.

With wise and regular observation of the large numbers going through works' training schools and alternative part-time day courses, for the purpose of selecting those clearly able to succeed at a higher level in the industry given the opportunities (this would never be more than a small fraction), the wastage of the past should not be repeated, but instead a much-needed source of manpower of assured quality and potentialities would be created. The leading engineering and industrial concerns by alluring advertisement and systematic interview are now in active competition one with another for the most promising students and graduates of our principal technical colleges and universities. Little, if anything, is done, however, in an organised way to assess and tap for wider opportunities the human material ordinarily destined for craft and allied employment.

The two essential needs which I have mentioned are related to some extent, since the numbers coming forward as the proved cream from the works' schools intake would increase the initial material out of which the future *élite* of the profession and industry would be expected to develop, and for which the higher training and experience would be organised.

Throughout training, the need to take full advantage of progress in science and technology should be continually emphasised, with the object of minimising delay between discovery and application of knowledge arising from research.

The Institution and Research

It was mentioned in the opening remarks that the Institution has made notable contributions to research in mechanical engineering as required by its Charter, which states as one of its duties : " To encourage invention and research in matters connected with Mechanical Engineering and with this object to make grants of money or books or otherwise to assist such invention and research." As an example of research sponsored by the Institution may be mentioned the work of Beachamp Tower upon friction of lubricated journal bearings in the reports to the Institution's Research Committee on Friction (1884–91) is widely known and valued. Early recognition of the importance to mechanical engineers of metallurgical study and research is reflected by the series of reports, extending over thirty years (1891–1921), to the Institution's Alloys Research Committee by the late Sir W. C. Roberts-Austen with his collaborators and other distinguished metallurgists who succeeded him in responsibility for the later reports. More recently, the work of the Institution's Marine Oil Engine Trials Committee resulted in an important series of tests and investigations of the performance and detail behaviour of actual marine oil engines of different designs and types, both on the test bed and at sea, producing a monumental collection of authoritative information and data, unique and valuable to this day for comparison with the behaviour of engines of current design. Subsequently, the Institution initiated research upon steam pipe flanges, but thereafter its direct activities in initiating and sponsoring mechanical engineering research virtually ceased, leaving its place to be taken by the organisation or participation in symposia of international character and status on subjects of importance to mechanical engineers—for example, 1937 General Discussion on Lubrication and Lubricants, 1947 Centenary Lectures on Mechanical Engineering, 1951 General Discussion on Heat Transfer (with the American Society of Mechanical Engineers).

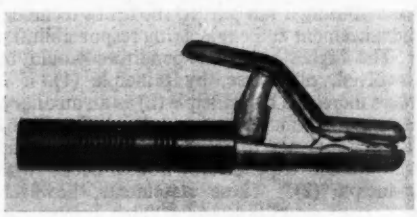
In these the Institution has co-operated particularly with the American Society of Mechanical Engineers. Additionally, of course, the Institution has, throughout, published papers which have reported the results of important researches. These have invited, and have had the benefit of, discussion by its members and others of expert and professional competency. This has been aided considerably, as you all know, by the Institution's organisation of specialist groups concerned with specific branches of mechanical engineering.

Probably the principal new factor responsible for the change noted in the Institution's practice concerning mechanical engineering research, has been the arrival and growth of industrial research associations in making provision for research in an industry or one of its branches.

The questions may well be asked whether the present situation is wholly satisfactory from the Institution's standpoint ? Whether, in fact, the collective professional knowledge and experience of its members could be used more effectively ? At the present time this would seem to be largely fortuitous, depending upon the normal discussion of papers as they arise. Although many members, in their individual capacities as members of committees of research associations, do take an important interest in the work and researches of these associations, this is not as direct representatives of the Institution. The question which arises is whether there is need for more positive interest by our Institution in certain cases—for instance, those subjects which are of unquestioned technical and scientific interest to our members. In other words, whether the influence of the Institution can be made more specific than which arises from the discussion of papers put forward on behalf of research associations, or dealing with subjects in which they may be concerned, and of which the paper offered may be the first official notice the Institution has of the subject having received attention.

Welding Electrode Holder

The accompanying illustration shows the " Lincoln-Jackson A–3S " electrode holder, now produced in this country by Lincoln Electric Company, Ltd., Welwyn Garden City, Herts. The holder is insulated throughout and is made from 35-ton per square inch hard copper alloy, having an electrical conductivity 35 per cent that



Electrode holder of high tensile copper alloy, showing completely insulated design

of copper. While accidental arcing is prevented by the insulation, the insulated crown channel jaws and the long handle give the holder more heat resistivity and make for cooler operation. It is stated that all spares are easily replaceable and can readily be insulated.

Baghdad Trade Fair

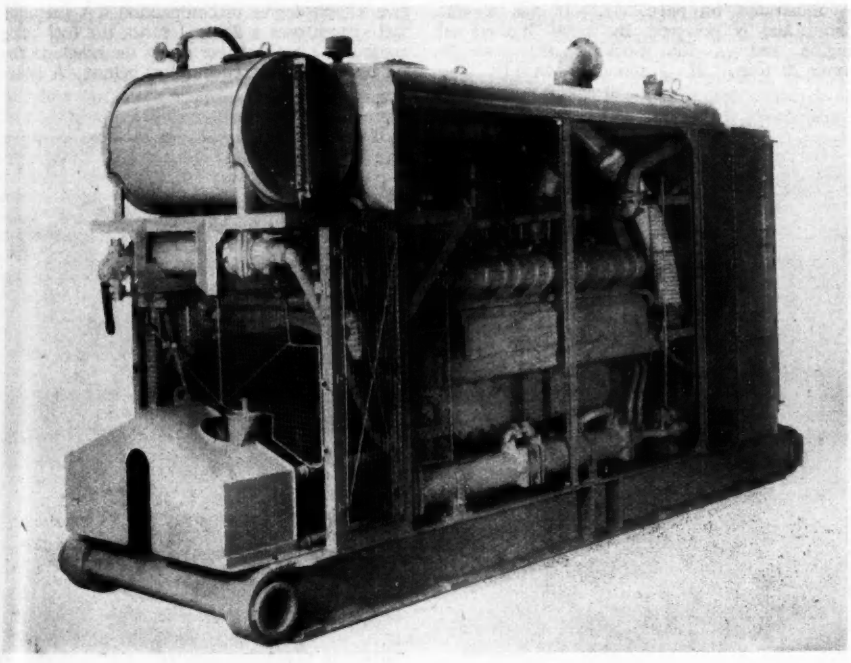
ON Monday next the British Trade Fair will be opened at Baghdad by King Feisal II of Iraq. This fair will be the largest of its kind ever held in the Middle East, and at it the products of more than 400 British firms will be shown. It has been organised by British Overseas Fairs, Ltd., a subsidiary company of the Federation of British Industries, to show the countries of the Middle East the contribution this country can make to assist their development plans. A high proportion of the exhibitors are associated with the engineering and allied industries, and although the emphasis is mainly on capital equipment, a representative display of consumer goods is included. The exhibits will include mechanical and electrical engineering equipment, transport vehicles, motor-cars, cycles, agricultural machinery, contractors' plant, radio and television equipment, machine tools, oilfield equipment, &c. A majority of the plant shown has already been dealt with in THE ENGINEER, but an idea of the scope of the exhibition will be obtained from the following brief notes on some of the plant and machines.

A feature of particular interest at the exhibition will be a 30ft by 30ft ice rink, designed and manufactured by J. and E. Hall, Ltd., of Dartford, which is intended to demonstrate the way in which this country can provide equipment for the most unusual conditions. The rink has been laid down in an air-conditioned building and the 2700ft of piping in the floor has been set in damp sand. The refrigerating plant comprises a twin-cylinder monobloc compressor driven by a 30 h.p. motor and using " Arcton 6 " as a refrigerant.

In addition to the comfort of the spectators and the reduction of the temperature in which the ice rink was to be placed, the maker had to take account of factors of fog and condensation. The moisture condition of the air would naturally be considerable and some guard had to be made against condensation, which could be most inconvenient and completely ruin the interior decoration in a very short time. For this reason an air conditioning plant has been installed consisting of a four-cylinder compressor with a horizontal shell and tube condenser and a direct expansion finned air cooling unit and two banks of filters. Conditioned air is delivered into the building through grilles and diffusers and returned by means of underground ducts.

As oil engines are now so widely used in Iraq and neighbouring countries for public services and irrigation purposes it is natural that a number of leading manufacturers should show typical examples of the engines they make for driving generators, pumps, contractors' equipment, &c. Amongst the oil engines exhibited by Ruston and Hornsby, Ltd., Lincoln, there will be many typical diesel alternator sets. One of this firm's 200kW alternator sets driven by a five-cylinder engine developing 300 b.h.p. at 500 r.p.m. is to be used in conjunction with engines of other makers to supply current to the main feeder panels for distribution throughout the fair. A model of one of the firm's " 4 YE " engines, rated at 75 b.h.p. at 1500 r.p.m., is cut away at various points and fitted with transparent plastic covers to show its operation.

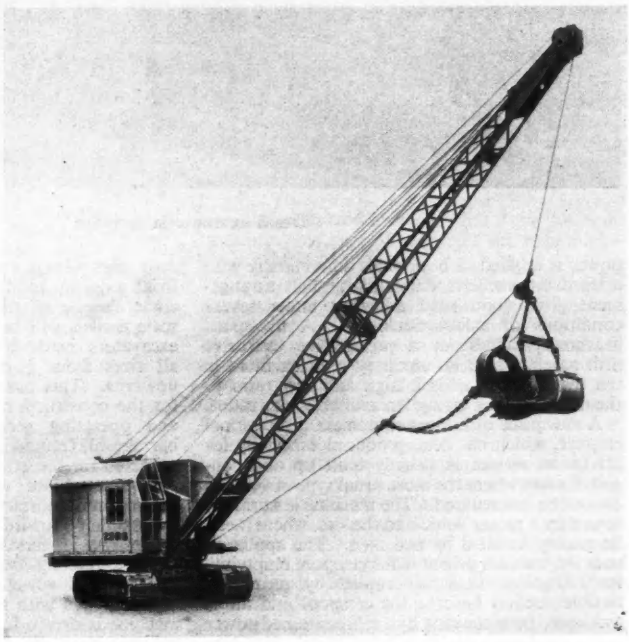
The main exhibit of Davey, Paxman and Co., Ltd., Colchester, will be one of the Ruston-Paxman 12 R.P.H. Series II " Package " sets for oil well drilling. These sets are made in various sizes with four, six, eight, twelve and sixteen cylinders with shaft horsepowers from 130 to 665, and the twelve-cylinder set to be shown is illustrated on this page. It develops 500 b.h.p. at 1250 r.p.m. These engines are designed for rigorous duties and are suitable for fitting to rigs of either British or American manufacture. They are light and compact and are built up of a number of sub-assemblies, each of which can be removed without disturbing the others.



Twelve-cylinder 500 b.h.p. oil engine for oil well service

The National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne, is exhibiting two of its " M4A " vertical oil engines, one with three and the other with six cylinders and having outputs of 82 and 165 b.h.p. respectively. These engines are coupled to Brush generators and each is mounted on a baseplate and provided with a radiator for cooling purposes. In the case of the six-cylinder engine the generator is flange mounted. Starting is by means of the Berger " Handraulic " system.

The smallest of three typical horizontal diesel engines to be shown from a range covering



¾ cubic yard universal dragline excavator

3 to 90 b.h.p. develops 3/5 b.h.p. at 1000/1500 r.p.m. It is available for either hopper or tank cooling and a half-speed extension shaft and arrangements for power take-off allow of many applications. A two-flywheel engine, which develops 12 b.h.p. at 600 r.p.m., is of simple design and can be operated by unskilled labour. A larger horizontal diesel engine of the firm's " NXA " type is rated at 80 b.h.p. at 220 r.p.m.

An exhibit of particular interest to be shown amongst the products of R. A. Lister and Co., Ltd., Dursley, upon the stand of its agents, W. J. Coker and Co., Ltd., is the new A.D. engine, recently put into production. This air-cooled diesel engine runs at from 900 to 1800 r.p.m., giving horsepowers from 1¾ to 3½ respectively at these speeds. It weighs some 250 lb and has been designed to operate in the extremes of tropical heat. An integral reduction gear in the engine gives a speed ratio of 2 to 1.

One of the largest stands in the exhibition will be that of Rolls-Royce, Ltd., Derby, which is showing its motor-cars, aero-engines and oil engines. The three basic designs of oil engines to be shown include the four and six-cylinder supercharged and an unsupercharged eight-cylinder design, in a power range from 80 to 330 b.h.p. These engines have a common bore and stroke and identical parts are widely used.

The Rolls-Royce commercial vehicle petrol engines will include a four-cylinder, 2838 c.c. engine, a six-cylinder, 4256 c.c. engine and an eight-cylinder, 5675 c.c. engine with powers ranging from 80 to 200 b.h.p. A number of other engines for various applications will also be shown.

Amongst the heavy motor vehicles which will be displayed is one of the " Jubilant " chassis of Dennis Bros., Ltd., Guildford. This six-wheeled vehicle has a 110 h.p. diesel engine and is designed for a payload of 12 tons. Its four rear wheels, each equipped with twin tyres, are mounted in a centrally pivoted bogie and

Trench excavator in operation

power is applied to both axles differentially with a third intermediate differential. This arrangement gives good road adhesion under severe conditions of axle articulation. A five-speed gearbox provides for a preselective overdrive fifth speed, whilst an auxiliary gearbox fitted in the transmission adds a high and low ratio to the main gearbox giving ten available gear ratios.

A new piece of Dennis equipment is a cesspool emptier, which has been produced especially for sanitation service in heavily built up and congested areas where the more usual type of vehicles cannot be manœuvred. The machine is normally towed by a motor vehicle to the site, where it can be readily handled by two men. The appliance uses the vacuum principle for cesspool emptying. Its 150-gallon tank is coupled by means of flexible suction hose to the cesspool and air is evacuated from the tank by a self-contained power unit and pump consisting of a Dennis 4½/7 h.p. air-cooled petrol engine and a "Hammond" rotary air pump. A two-way valve is provided to enable the pump to create pressure under the tank for discharge.

The two heavy-duty vehicles to be shown, together with marine and industrial oil engines, by John I. Thornycroft, Ltd., Smith Square, London, S.W.1, are a "Trusty" 10 cubic yard hydraulically-operated, end-tipping dump truck, and a "Big Ben" 20-ton machinery transporter. The dump truck chassis has a 13ft 5in wheelbase and is fitted with a six-cylinder, 100 b.h.p. diesel engine.

The second exhibit, which is illustrated below, is a heavy-duty tractor of 13ft 6in wheel base fitted with a 11·33-litre, 155 b.h.p. engine with a maximum torque of 508 lb-ft at 1000 r.p.m. Power is transmitted through a single-plate clutch to a four-speed main gearbox, to which is coupled a two-speed auxiliary gearbox and a power take-off for a winch drive. The bogie axles have overhead worm drive and are equipped with Michelin "Metallic" tyres. Air pressure brakes operated from a two-cylinder compressor fitted to the engine act on all wheels, but the multi-pull mechanical hand brake acts on the rear wheels only. A power take-off drives a winch with a 25,000 lb pull.

The semi-trailer with this tractor is a "Crane" design with heavy automatic coupling, detachable rear axles and detachable front crank. It is manufactured with a low loading frame of electrically welded construction for carrying heavy machinery. Each complete axle assembly turns in pivot brackets and accommodates the wheel load evenly under all conditions of ground surface. Loading ramps are supplied for all possible methods of loading.

A "Rapier 5" mobile crane to be shown by Ransomes and Rapier, Ltd., Ipswich, is designed for working loads of up to 15,000 lb. It is a diesel-electric-driven machine with independent motors for travelling, slewing, hoisting and derricking. The "self-steering" mechanism gives easy control on the steering wheel and very rapid manœuvring with a 90 deg. steering lock on each side. The crane can revolve on its own road wheels about the centre point of the front axle, in addition to the independent full circle slewing of the superstructure. A set of scale models will be used to show the range of excavators made by the firm, which includes all sizes from ¼ cubic yard bucket capacity upwards. This company obtained the contract for the construction of the water control gates and operating gear for the Wadi Tharthar barrage, and a model of one of the gates has been prepared for the exhibition.

Five machines representative of its road-making and contractors' plant are being shown by Aveling Barford, Ltd., Grantham—a road roller, two graders and two dumpers.

The "Aveling-Austin 99-H" motor grader is fitted with all-wheel drive and all-wheel steering and equipped with full hydraulic control. This machine is driven from a 100 b.h.p. six-cylinder diesel engine. Its 13ft blade can be completely reversed and moved to any banking position, including the vertical, without the operator leaving his platform. By using all-wheel steering to offset the rear wheels, it is possible for the blade to reach 10ft 1½in beyond the outside rear tyre. A light maintenance grader, designed for smaller work, is fitted with a 42 b.h.p. diesel engine and has a working weight of 8000 lb.

The earth-moving machinery exhibited also includes a model ¾ cubic yard universal excavator made by Ruston-Bucyrus, Ltd., Lincoln. The machine shown will be equipped as a dragline, as illustrated on page 557. It has a 40ft boom and is powered by a 66 h.p. diesel engine and in full working order weighs some 20 tons. It is mounted on 12ft long caterpillar tracks and has a bearing pressure of 6·94 lb per square inch. When required the machine can be easily converted to a shovel, dragline, drag shovel, skimmer, grabbing crane, crane, or pile driver. This firm is also exhibiting a "22-RB" positive shock-absorbing rope-crowd shovel equipment, with an 18ft boom and a ¾-yard dipper.

A trench excavator made by John Allen and Sons (Oxford), Ltd., Cowley, and shown herewith is fitted with a 14ft boom and is driven through a five-speed gearbox giving a travelling speed of 1·66 m.p.h. and five digging speeds from 4·38in to 35in per minute. Its cast alloy buckets are supplied in five widths suitable for cutting trenches from 16in to 36in wide to a maximum depth of 14ft. If required, side cutters can be fitted between the buckets to enable trenches up to 60in wide to be cut. A positive cleaner is fitted to eject sticky material from the buckets and an adjustable safety clutch protects the transmission.

The boom can be shifted to either side of the machine centre line in order to enable trenches to be cut close to walls or similar obstructions. The double-sheave boom hoist is operated by a self-locking worm gear and gives positive crowding of the buckets into the digging independent of the resistance. A safety device protects the hoist from overwinding.

The conveyor is designed to discharge to either side of the machine; it is fixed at constant height and can be folded for travelling. The frame is of riveted construction with three-point suspension for the caterpillar tracks, which permits small unevennesses in the ground to be accommodated. The treads are 19in wide and smooth-surfaced to minimise damage to roads. The machine will clear obstacles 15in high and can operate uphill or downhill on any gradient up to the limit of its tractive power. All the control levers are mounted in one bank (at the right-hand side of the machine when looking in the direction of travel), an arrangement which allows the driver to operate the machine without leaving his seat.

In addition to a selection of pumps, Pegson, Ltd., of Coalville, Leicester, is showing a small granulator, a vibrating screen, and a recently introduced improved design of portable power rammer. The new rammer weighs 208 lb and when working it is guided over the ground by the operator's grip on a conveniently positioned fixed ring near the upper end.

The machine is actuated by an integral two-stroke cylinder of 102·5 c.c., which is designed to impart to the rammer sixty to eighty jumps of about 20in per minute. At each operating cycle the machine strikes the earth with a blow having a potential energy of some 346ft-lb to give a high degree of compaction. A petrol/oil fuel system uses a 24 to 1 ratio, the fuel being carried in a tank at the top of the machine and fed by gravity to a carburetter below. A heavy

Diesel engined heavy-duty tractor, for the Middle East

dome at the top of the rammer gives ample protection to the magneto and other principal moving parts against weather or accidental damage.

Babcock and Wilcox, Ltd., will occupy a stand jointly with Stewarts and Lloyds, Ltd., and the United Steel Companies, Ltd., and its display is designed to indicate the boiler plant and pressure vessels it makes. Photographic enlargements and transparencies will show important power station and industrial steam installations, with particular emphasis on plant most suited to the Middle East, where, for example, oil fuel is most widely used.

The exhibits will include a scale model of an oil-fired integral furnace land boiler, and photographs will show how this class of boiler is being used, frequently in outdoor installations without a housing, in oil refineries and other industrial plants. Other models will show typical marine and waste heat boilers, cranes, &c.

It is natural that a big selection of pumps will be shown in view of the outstanding part that irrigation plays in all aspects of domestic, industrial and agricultural life in the East. Amongst the firms exhibiting pumps of many sizes and different kinds will be Tangyes, Ltd., Birmingham; Mather and Platt, Ltd., Manchester; Drysdale and Co., Ltd., Glasgow; Lee, Howl and Co., Ltd., Tipton.

The electrical plant to be shown by a number of manufacturers includes generating plant for industrial and large-scale public works, as well as a selection of domestic equipment

The British Steel Piling Company, Ltd., of London, is using a scale model to demonstrate the operation of its 68/80ft universal pile driving equipment, with which can be shown the method of driving both vertical and raking piles as in typical quay or jetty construction. Such a plant is equipped with telescopic leaders, 80ft in length, with a 5-ton single-acting hammer. The plant is mounted on a girder capable of being travelled on rail tracks supported by temporary timber gantries. It is provided with power-driven gearing for travelling the machine along the girder, and also for the raking, rotating and leader sliding mechanisms. Such a plant is capable of handling piles up to 10 tons in weight.

An interesting model to be shown by Imperial Chemical Industries, Ltd., is a floating purification plant for water supply to outlying communities. This plant takes in water from the river on which it floats and pumps the purified water to nearby villages by pipeline. It is constructed of light aluminium alloy and can be towed up or downstream to supply the village or area most in need of its services. The first full-scale plant, which has a capacity of 2400 gallons per hour against a 70ft head, will arrive in Iraq towards the end of the year. This plant was constructed by Marston Excelsior, Ltd., a subsidiary company of Imperial Chemical Industries, Ltd., and designed in conjunction with a consulting engineer acquainted with water problems in the Middle East.

Hurlingham Cement Distribution Depot

The Cement Marketing Company has completed a new depot for the handling of cement; 6000 tons per week can be distributed by road from the depot, which is intended to serve Greater London and to replace three existing depots.

THE Hurlingham depot of the Cement Marketing Company, Ltd., which recently came into use, is intended as a centre for the distribution of cement, by road, to the company's customers in the Greater London area. It is situated on the north side of the Thames, just above Wandsworth Bridge, and cement is brought to it by lighter, from three of the Blue Circle group's Thames-side cement works. The depot can store 6000 tons of cement—that is, one week's capacity for the handling plant—and is equipped to unload and store the cement, and to transfer it to lorries in bulk or in bags, all of which is done mechanically and can be carried on in all weather conditions.

The first of our illustrations shows the new depot from the river. The layout of the building can be followed from this illustration; three unloading points, where adjustable bucket elevators take the cement from the lighters, can be seen. There are three screw conveyors leading to the central tower, where a system of elevators and air slides takes the cement to the twelve storage silos. There are four rows of three silos to the right of the tower. Air slides are used to extract the cement from the silos and take it to the packer elevators. The conveyor and packing plant for the bagged cement is housed to the left of the central tower, and includes loading bays for lorries on the other side of the building. The loading bays for "bulk" lorries are situated roughly behind the central tower, and the lower building on the right of the illustration contains stores and workshops for repair and maintenance. Vacuum extraction plant is installed throughout the depot to give dust-free conditions.

The packer and loading buildings have a reinforced concrete frame clad with asbestos cement sheeting, except at the lower levels, where concrete blocks are used. They are designed to L.C.C. requirements. Extensive works were also necessary at the Kent cement works, near Greenhithe, to provide bulk loading for the lighters. In the following paragraphs the various elements of the cement handling plant are described in more detail.

Lighters.—Nine lighters, worked normally in groups of three, are used to supply the Hurlingham depot. Each has a nominal capacity of 330 tons, and is self-unloading with a discharge rate of about 50 tons per hour. The discharging system comprises a cross scraper conveyor elevator amidship across the lighter, to collect cement from floor level and to deliver it to a small hopper formed in the deck. This hopper forms the boot of the unloading bucket elevator supported on the wharfside which delivers the cement to the conveying system feeding the silos.

The holds of the lighters have false floors formed of air fluidising conveyors sloping at 8 deg. from the fore and aft bulkheads towards the centre of the lighters, finishing flush with the trough of the scraper elevator. Each floor is divided into eight sections, each forming a longitudinal conveyor running from one end of the lighter down to the amidships section. A separate air feed is taken to each conveyor at its lowest point, these sixteen air pipes being brought through the deck across the centre of the lighter and joined to an air manifold; a cock on each pipe controls the air to whichever conveyor is required, and a flexible pipe connects the manifold to a blower on the quayside by each unloading station.

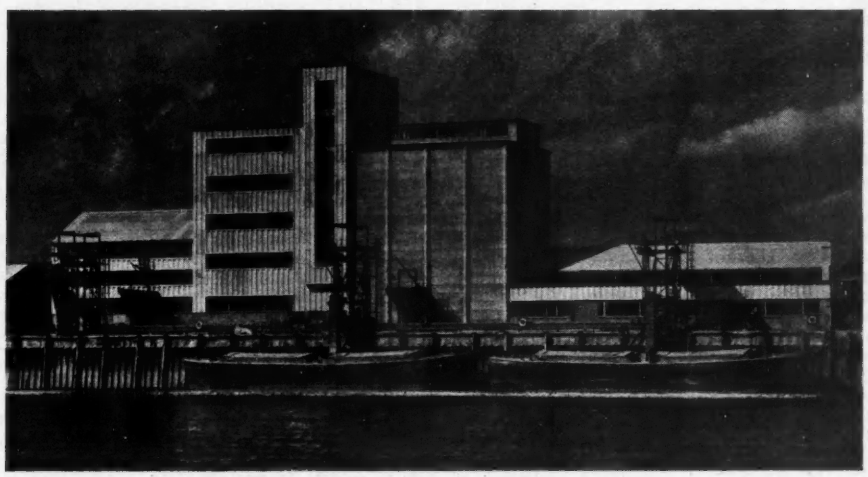
The centre of the lighter, where the scraper elevator is placed, is partitioned off by two transverse bulkheads running from deck level to 1ft above the air conveyors, thus isolating the machinery from the bulk of the cement in the holds. Longitudinal wash plates run from these bulkheads to halfway along each hold from deck level to the air conveyor surface. These plates stabilise the lighters whilst they are being loaded with fluidised cement.

The drive for the transverse scraper elevator is a 7½ h.p. geared motor positioned on the deck of the lighter. A flexible cable, with a plug, runs from the motor to a starter with an integral socket, mounted on the side of the unloader elevator. Thus, the 415V, 50 c/s, three-phase supply is carried from the wharf. An emergency stop button is fitted on the lighter itself, but otherwise there is no electrical control gear on board. The drive is interlocked with the conveying equipment to the silos so that if any hold-up occurs in this part of the plant the lighter discharge automatically stops.

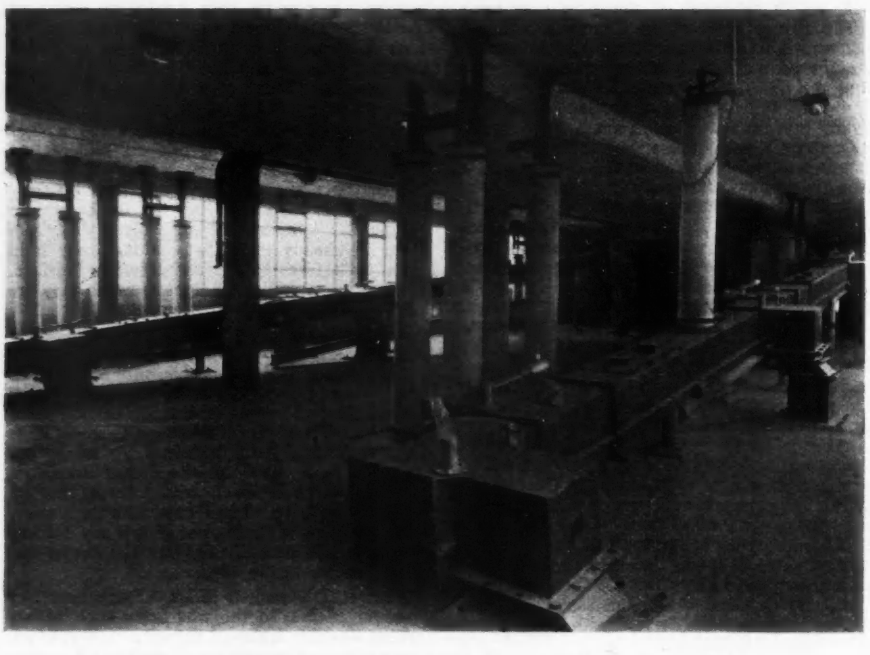
Cement Transport to Silos.—There are three fixed unloaders on the wharfside, each with a bucket elevator, having a capacity of 50 tons per hour, mounted on a pivoted system which enables the elevator to move with the lighter as the tide varies. When the lighter is in position, the elevator is lowered down into the deck hopper by a hand winch and an apron is provided on the elevator case to connect to the flange of the hopper so that a dust-tight connection is formed. A screw conveyor is flexibly connected to the bucket elevator; it discharges into a system of 20in/24in diameter screw conveyors which run along the front of the wharf to a mid-position, where they discharge into a 24in diameter screw, which transports the cement to the silo conveying system.

The cross screw which brings the cement from the wharfside conveyors discharges into an 86ft high slow-speed central discharge elevator with 24in buckets, which takes the cement to the top of the silos and discharges it either directly or through a cross air slide into one of two air slides, illustrated on page 560, which run along the length of the silo block. The elevator and each air slide have a capacity of 150 tons per hour. The cement can be directed into the silo required by swivel ploughs. (The centre row of silos is served by both air slides, but the outer rows by one only). Two high-speed fans, each having a capacity of 475 cubic feet per minute at 30in W.G., provide the air for the slides; only one fan is normally required.

The main screw conveyors along the wharfside are at ground level and special precautions have been taken to render them waterproof. The covers are self-sealing and provision is made for



Lighters discharging cement at the Hurlingham depot



The two air slides shown here run along the length of the silo block, and discharge into swivel ploughs and hence into the silos

draining away any water that might get into the seal.

Silos.—The silos form a compact rectangular block divided into twelve silos arranged in three rows of four. The total capacity is 6000 tons, but the silos in the centre row are terminated 9ft above the outer rows, the space so formed being utilised for the extraction air slides. Provision is made in the north row of silos for bulk loading.

Each silo is provided with three internal air slides for the extraction of the cement stored in it, arranged in arrow formation to fluidise the lower layers of cement : the centre one is 12in wide and the other two 8in. The cement from the silos is conveyed to the packing plant elevators by two 12in by 150 tons per hour air slides, the rate of discharge from the silo being controlled by an air feeder. One feeder is provided for each of silos 1–4 and 9–12, but for the centre silos two feeders are provided, so that the cement in this row may be delivered to either of the main extraction air slides. Cross-over air slides are provided so that either extraction air slide may discharge into either packing plant elevator. Two blowers, each having a capacity of 520 cubic feet of air per minute at a pressure of 3 lb per square inch are provided for the air slides inside the silos and two high-speed fans, having a capacity of 450 cubic feet of air per minute at 30in W.G. are provided for the air feeders and the two main extraction air slides, but only one blower and one fan are required at any one time. The blowers and fans are arranged for this purpose on a platform at ground level below silo No. 5.

The supply of air from the blowers is controlled automatically by electrically-operated unloading valves, controlled by the high and low-level device in the packer hopper. The whole of the conveyor system is interlocked to ensure correct operation.

Packing.—The packing machine is a twelve-spout " Fluxo " plant of 100 tons per hour capacity, comprising a 24in slow-speed, central-discharge elevator, a rotary screen, hopper, pneumatic feeder and packer and dust filter. A control board is provided next to the machine to control all this machinery, the electrical equipment being of the contactor type arranged in a separate cubicle on the second floor of the building. High and low-level devices are provided in the packer feed hopper to ensure that the head of cement on the machine is kept within the prescribed limits.

The " Fluxo " plant is illustrated here. As may be observed, it consists of a number of nozzles mounted on a rotating head. A bag is placed on the nozzle and is filled, as the machine rotates, and sealed and automatically discharged on to the loading conveyor system. The bags are fed on to the machine by hand, one operation lifting the " lip " of each bag of the pile, and a second taking the bag and placing it on the spout of the " Fluxo " machine. Apart from the loading of the bagged cement discharged on to the lorries by the retractable conveyors, this stage appears to be the only one where manual intervention is necessary as a normal part of the operation of the plant.

Only one " Fluxo " packer has been installed at present, but there is provision for the installation of a second one, should it be required.

An air compressor, having a capacity of 100 cubic feet of air per minute at a pressure of 30 lb per square inch, is provided to operate the pneumatic equipment. Provision is made for the installation of a second one. This compressor is driven through a hydraulic coupling so arranged that when full pressure has been reached in the air receiver, the compressor automatically stops running, the motor continuing to run normally. With this arrangement it is hoped to reduce the maintenance on the compressor.

Loading Bay.—The loading arrangements comprise a 24in flat belt conveyor of sufficient length to allow for a future loading point to make a total of four. A burst bag hopper is provided at the end of the belt, the intention being that the burst bag attendant should lift the plough if he sees a damaged bag, so that it goes over the end of the conveyor. When changing loading points the plough is operated from a point adjacent to the retractable conveyor. A 12in/16in screw conveyor takes the cement from the hopper back into the main packer elevator, but the burst bags must be removed from the hopper by hand. The screw conveyor runs below the loading floor, but openings are provided at intervals of 10ft 6in into which spilt cement may be swept. Three 24in flat belt retractable conveyors are provided, suitable for loading the longest lorries now in use.

The bag store is arranged over the loading bay and when stacked to a height of 9ft (the maximum permissible) it has a useful capacity of about 750,000 bags.

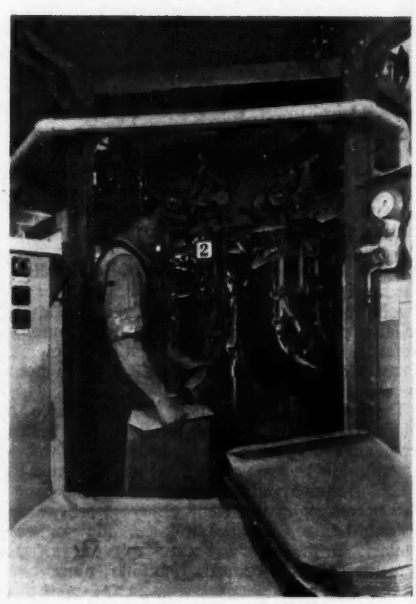
Bulk Loading.—The elevator screen and hopper for the second packer forms an easy method of obtaining screened cement for bulk loading. The cement is taken from this hopper through a pipe and a flexible hose to the waiting vehicle, and provision is made to ensure, as far as possible, that the operation of filling the lorry shall be dust-free. A gangway underneath the main canopy is provided for access to the lorry top.

Power Supply.—Two alternative power supplies are provided by the London Electricity Board, whose substation is at the north-west corner of the site. A 500kVA transformer provided by the Board reduces the incoming supply from 11kV, three-phase, 50 c/s, to 415V, three-phase, 50 c/s, which is the voltage of the supplies throughout the works. Two feeders connect the Board's substation with the works' substation in the basement of the packer building. The main switchboard in this substation is divided into two by a section switch, and the Board's two feeders are connected, one to each half : this should ensure that at no time is the whole of the plant shut down as the result of a fault, and it also permits maintenance being carried out on half the board while the other half remains in service.

There are a number of distribution boards throughout the plant which are supplied from the main switchboard in the works' substation, and which in turn gives supply to the adjacent machinery. All starters are fitted with isolating switches and, where necessary, emergency stop push buttons are provided

Extensions at Kent Works.—To provide facilities for bulk loading the lighters has necessitated extensive development schemes. At Kent Works, Stone, near Greenhithe, the cement is extracted from nine existing silos and from two new reinforced concrete silos by a system of air slides which convey it to six 27½in diameter screw conveyors. The capacity of the existing silos is 15,000 tons—approximately 1760 tons each—whilst the two new silos have a capacity of 1500 tons each, being 28ft inside diameter by 80ft high.

The screw conveyors feed to a belt conveying system having a capacity of 300 tons per hour, the belts being 36in wide and running at a speed of 300ft per minute. The first belt is about 765ft long and runs first along the ground and then in a gantry over the existing jetty to a transfer tower carried on a piled dolphin. The second belt conveyor is about 330ft long and is run in an overhead gantry to two discharge houses built on a new reinforced concrete jetty 150ft long and 30ft wide, also supported on concrete piles. The jetty is arranged to accommodate three lighters, one being filled from the first discharge house and two from the second house. The method of filling the lighters is by air fluidising conveyors extracting from hoppers located in the two houses. One lighter only is filled at any one time, the loading rate being the capacity of the conveying system, i.e. 300 tons per hour ; therefore, one lighter is loaded in approximately one hour, at any state of the tide. An automatic weigher is arranged on the belt conveyor leading to the new jetty to record the tonnage of cement loaded, and the whole of the conveying system, including belts, screws and air conveyors, is electrically interlocked so that



" Fluxo " packer for loading cement into bags

the plant can be shut down from a central position on the new jetty as well as at the various individual starters.

The engineers, main contractors and suppliers of plant for the works described in this article are as follows :—

HURLINGHAM DEPOT

Civil engineering consultants, Oscar Faber and Partners ; civil engineering construction, John Mowlem and Co., Ltd.; steelwork, Redpath Brown and Co., Ltd.; asbestos cement sheets, Universal Asbestos Manufacturing Company, Ltd.; mechanical handling equipment, elevators, conveyors and hoppers, Barry, Henry and Cook, Ltd.; air slide conveyors, Constantin (Engineers), Ltd.; retractable conveyors, Robert Boby, Ltd.; " Fluxo " packer, F. L. Smidth and Co., Ltd.; bag elevator, Bagshawe and Co., Ltd.; dust plant, J. Darnley Taylor, Ltd.; vacuum cleaning plant, Sturtevant Engineering Company, Ltd.; weighbridge, W. and T. Avery, Ltd.; air slide fans, Alldays and Onions, Ltd.; compressor for packing plant, Broom and Wade, Ltd.

Electrical Equipment.—Motors and geared motor unit, British Thomson-Houston Company, Ltd.; motor starters, G. Ellison, Ltd., and Allen West and Co.; fuse gear and distribution boards, English Electric Company, Ltd.; electrical installation, Barlow and Young, Ltd.

KENT WORKS

Jetty conveyor trestle supports, transfer tower dolphin and silos, Bierrum and Partners, Ltd.; belt conveyors, gantries, trestles, transfer tower and discharge houses, Robert Boby, Ltd., erected by Lloyd Lawrence, Ltd.; screw conveyors, Barry, Henry and Cook, Ltd.; air-activated conveyors, Fredk. Braby and Co., Ltd.; electrical installation, Cable Jointers, Ltd.

Packaging Research and Development Centre

DURING recent years it has become increasingly recognised in the engineering and allied industries that the correct packing of equipment to avoid loss by damage in transit is of particular economic importance. The advantages gained by increasing productive capacity may well be lost if the equipment made is unsuitably packed and arrives at its destination in a damaged condition. This particularly applies to delicate instruments and mechanisms, equipment for export, and to goods which have to be stored in their packings under adverse climatic conditions. Packing materials and techniques have now been developed and are being widely used to provide protection during transport and storage against damage by impact, vibration and corrosion. One firm which has carried out much development work in packing in this country is the Export Packing Service, Ltd., of Staplehurst Road, Sittingbourne, Kent.

This firm, which was formed some eight years ago, specialises in the preservation and packing of all forms of equipment for the aircraft, motor, electrical and electronic industries. It now has four centres, each fully equipped for scientific packing and, with a view to developing the best possible materials and techniques to suit individual problems, it recently opened a research and development establishment at Sittingbourne.

The new research building has a floor area of some 16,000 square feet and its main ground floor is laid out with laboratories, workshops, test houses and drawing-offices. The second floor contains administrative offices, a conference room and cinematograph theatre, and additional laboratories. A large amount of packing technique development work is done by the company for both the Government and industry. Each individual piece of work is planned to a schedule and its progress recorded on large wall charts by means of coloured discs. The system is simple to operate and shows at a glance the completed and unfinished stages in any development in hand, and at present some three hundred items of packing development work are in progress in the laboratories and drawing-offices. An important function of the establishment is to keep abreast of all the forms of packing materials and preservatives available, and in a special stores samples of every known material are kept for reference and laboratory test purposes.

When a packaging has been developed for a particular purpose it is tested in one or a number of ways in a large well-equipped test house to ascertain that it will meet all the known requirements. Many special recording and indicating instruments have been developed by the firm for use in this test house.

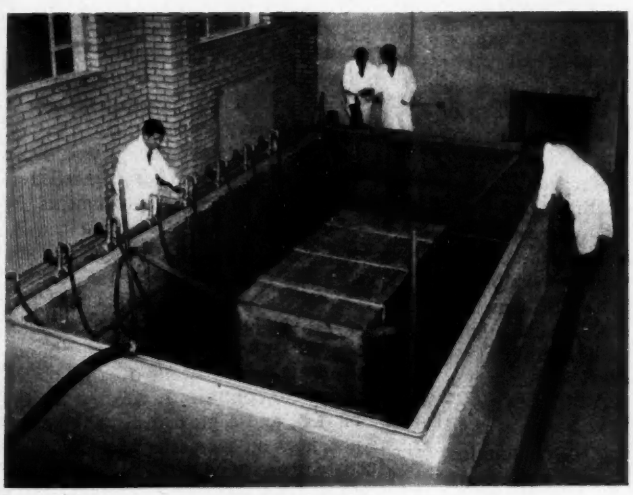
For one of these tests packing cases weighing up to 500 lb can be clamped on a vibrating table and vibrated at up to 900 cycles per minute at an amplitude of plus or minus $\frac{1}{4}$in. On an adjoining table similar cases can be bumped at up to four times a second with a free drop of 1in. These two tables are mounted on concrete blocks insulated by cork from the main building foundations.

An immersion tank, which is illustrated on this page, is used for the wet testing of crated goods. This tank is 20ft long, 10ft wide and 5ft deep, and has a series of nozzles round its sides. Jets of water from these nozzles are projected on to crates to simulate the effect of driving rain, and, if required, the crates can be completely submerged to ascertain their water-resisting capacity.

To test packing under conditions encountered in the tropics a humidity chamber, 9ft long, 9ft wide and 9ft high, has been installed. In this chamber a relative humidity of up to 100 per cent at a range of tropical temperatures can be achieved. By means of automatic controls these conditions can be arranged in cycles and maintained over prolonged periods. Smaller tropical testing chambers can also be used for moisture-vapour-penetration tests.

In one of the tests a packing case complete with its contents is hoisted to a height of several feet and then released to drop freely. For this test the contents of the case are connected electrically to an accelerometer to determine the deceleration on the contents when the case is dropped and an electric and a photographic record is made automatically.

We are informed that, in addition to its work of solving specific day-to-day packing and preservation problems, a programme of research is to be carried out. Included in this research will be the dynamic testing of cushioning and suspension media used in protective packing ; the examination and testing of equipment to assess fragility and establish definite safety factors ; the institution of tests revealing and recording the effects of hazards stemming from climate, transport, storage, corrosion, shock, &c.; investigation of new materials and techniques ; and the development of new forms of instruments better to simulate the effects of transportation and long-term storage. With this work of research it is hoped to build up a fund of specialised knowledge which will be available to manufacturers before and during the design and prototype stages of new products.



Immersion tank in which packing cases and materials are subjected to sprays of water to test weather-proofing

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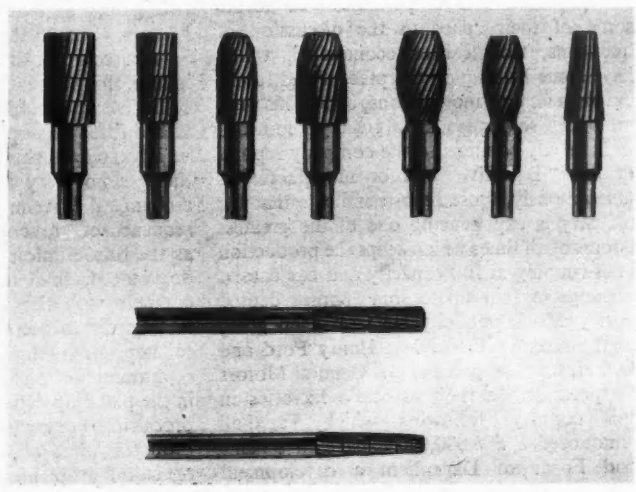
Segmental Tungsten Carbide Burs

ROTARY cutters built up from tungsten carbide segments were recently demonstrated by Flexible Drives (Gilmans), Ltd., 195, High Street, Smethwick, 41, Staffs.

In the design of these segmental burs, marketed under the name of " Segburs," a great saving in the amount of carbide is achieved, compared with the firm's solid precision ground carbide burs. Our illustration shows some of these burs which are built up to the required profile by brazing on to a steel shank four cutters selected from a number of basic shapes. These are made in three grades of carbide, moulded and sintered to size. The teeth are of sturdy design, and need not be assembled in alignment ; any staggering will have a chip-breaking effect. Should a tooth be fractured, the damage is localised, and the cutter concerned can readily be replaced by the user. Resharpening may be done either by lightly spinning on a wheel, or by rotating the bur in the chuck against a silicon carbide lapping stick, thus obtaining a peripheral grind. As with all carbide tools, high cutting speeds and sustained power are essential. At the demonstration, the working of chrome-molybdenum steel, " Nimonic " metal, and a number of other hard and tough alloys, was shown, the tool being driven at 24,000 r.p.m. from a flexible shaft.



Tungsten carbide burs, assembled in a variety of profiles by brazing four cutters on standard steel shank

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BEAM ENGINE AT ARBROATH.—Two museums in Scotland are considering the possibilities of acquiring a beam engine, which was built by James Carmichael, of Dundee, in 1839, and which is at present at the Wardmill Bleachfield of William Webster and Co., Ltd., Arbroath. The engine supplied power for the plant at Wardmill until three years ago, and thus completed 112 years' continuous service.

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THE MOTOR INDUSTRY—HOPES AND FEARS

The occurrence each year of such events as the Paris Salon de l'Automobile and the London Motor Show stimulates newspapers and other periodicals to devote some of their space to the discussion of questions, technical or economical, which have some bearing on the present and future development of motor transport. This year most British papers have given prominence in their city columns to the company reports of the "Big Five" motor manufacturers. Unanimously, those reports indicate that the industry is experiencing one of the greatest booms of all times which keeps the production lines running at full capacity and has caused earnings to soar up to some unprecedented peak. Much publicity has also been given to the recent visits of Mr. Henry Ford and Mr. H. Curtice, president of General Motors Corporation, to their associate factories in this country, following which Vauxhall announced a £36,000,000 expansion scheme and Fords of Dagenham a development programme costing about £65,000,000 spread over five years. Sir Leonard Lord, head of the British Motor Corporation, last month stated that his group of companies has made plans to meet the keenest competition. It is already committed to an expenditure of £10,000,000 for extensions of the plants at Cowley and Longbridge and much more, it appears, will actually be spent.

From these and other recently made statements it becomes abundantly clear that the motor industry is investing very large sums in machinery, equipment and tooling programmes, with the ultimate aim of virtually doubling within a few years its output of cars and commercial vehicles, which, at present, is running at the rate of 1,000,000 units annually, or double its pre-war peak! There is little doubt that, in future, competition between the major motor manufacturers must become very intense, especially in overseas markets, though at home it is unlikely to assume the same proportions as in America, where some of the few remaining independent firms have lost up to three-quarters of their outputs to the two giants of industry, Ford and General Motors. Should the same thing ever happen in this country, it would be a sad story indeed, for more than once in the history of British automobile engineering small specialised firms have played an important part in advancing technical progress. However, there is not very much point in deploring a change if it seems to be an inevitable consequence of an economic development. If, as the future unfolds, small specialised firms do, indeed, find it no longer possible to compete with the giants, as threatens unfortunately to become true, we shall have to hope that the more adventurous spirit of automobile engineering will remain awake in the planning departments of the big motor producing concerns. There are new and promising lines of approach to the solution of many problems which are still waiting to take practical shape. We can only hope that they may soon be opened up! Only a few will be optimistic enough to believe that increased production and stronger competition will necessarily bring about a substantial reduction in the price of new cars, but it is, at least, to be expected that the inadequate delivery position on the home market will improve even if a great proportion of the additional output should be earmarked for export only. Increased production should certainly help to shorten the still existing waiting lists for most of the popular models and to reduce to a reasonable level the inflated prices of second-hand cars.

But rosy as this outlook may appear, the fact that soon many more cars, buses and lorries will come on to Britain's overcrowded roads will raise grave apprehensions in the minds of those who have to consider it in its other perspective as a serious traffic problem. There is no doubt that our present roads are inadequate for the volume of traffic they already carry, let alone that which they are going to have to carry. Plans to improve our highways system have, of course, been drawn up for some time: they include schemes to build new trunk roads, widen existing streets, construct underground garages in cities, and other equally ambitious suggestions for continuous improvements. But apart from making regulations, such as those banning parking or waiting in busy main roads during certain hours and creating a rather confusing system of one-way streets, local authorities have not been allowed to tackle the admittedly difficult problem of large-scale improvement with any great success. Traffic jams in our big cities, with millions of pounds uselessly spent in wasted time and petrol, are a far too common occurrence, and there is still no definite indication that anything very much will be done to alleviate these conditions. One of the big objections to any really effective road improvements is, of course, the cost. Vehicle users, however, rightly argue that in fuel tax, purchase tax and what used to be known as "road tax," the Exchequer is taking from them something like £400 million a year, of which less than a sixth is spent on the roads, in maintenance, new construction lighting, &c. They can also show that many accidents are directly or indirectly caused by poor road conditions, and that the estimated loss to the country resulting from these accidents amounts to well over £130 million annually. No firm estimates, of course, can be made of the losses resulting from such causes as delays and premature deterioration of vehicles by badly surfaced roads, but it is, nevertheless, certain that even a very considerable expenditure on improving our highways would pay substantial dividends. What is needed is not isolated petty road improvements by local authorities, but a start upon a well-planned and urgent programme of national road-building. Moreover, in the context of this article, it should be emphasised that the British motor industry cannot rely entirely upon an export trade which can disappear overnight for reasons over which the industry has no control. It needs a healthy home market, and a great deal of the effort spent just now on increasing the industry's productive capacity will be wasted, unless road users are to be favoured by a more enlightened policy on road construction. We cannot do better than to remind the Minister of Transport of a speech, made by his predecessor, Mr. Lennox-Boyd, at the opening of the Commercial Motor Show in 1950, in which he said: "I wish that a Minister could command the funds so that I might have been able to build roads in this country worthy of this great range of vehicles." Mr. Lennox-Boyd did not build the roads; we wonder whether Mr. Boyd-Carpenter will do better!

RADIOACTIVE WASTES AND THEIR TREATMENT

The meeting held at the Institution of Civil Engineers on October 12th was the first occasion in this country when papers on the treatment of radioactive wastes have been published or presented for discussion. The

public health engineering division of the Institution has been active in encouraging the dissemination of knowledge on radioactivity, as it affects the public health engineer, and seems well aware that many of the division's members may be faced with such problems in their professional lives at some time in the future. In 1952 a lecture entitled "The Impact of Radioactivity on Public Health Engineering Services," by A. Key and A. W. Kenny, was delivered at the Institution and last week the papers "The Design and Construction of the Handling and Treatment System for Liquid Radioactive Wastes," by W. L. Wilson, and "Operational Experiences with a Handling and Treatment System for Liquid Radioactive Wastes," by R. H. Burns, were discussed at the division's meeting.

The papers deal with the treatment works at Harwell, built to the Ministry of Works' design, which have been successful in ensuring that effluents can be discharged into the River Thames, without any bad effects on the amenities of the river and the use of its water further downstream. It is evident from a perusal of the two papers that the treatment works at Harwell are no mean engineering achievement. The details of their design and operation may be learned from the papers themselves, but some general points may well be mentioned here to illustrate the nature of the problems which had to be faced and the degree of success with which they have been solved. "In November, 1945," Wilson states, "when the project reached executive staff, the total of knowledge at the Ministry of Works regarding the new science was of negligible proportions and very little more knowledge was then available regarding what had to be designed and built" From this humble start a treatment works was designed and built, which has been operated successfully for five years with few modifications. At the outset there was a choice of three purification processes, namely, precipitation (with or without filtration) distillation and ion exchange. The first method was selected as the only practicable one, with its success largely dependent upon "sound laboratory discipline and good housekeeping." Thus raw radioactive wastes are not discharged down the laboratory sinks, but are kept in adequately designed vessels until their radioactivity has decayed sufficiently to permit normal disposal. Rinsings from the laboratories, however, are so disposed of and the effluents are classified as "probably active" and "possibly active." The treatment of such effluents makes use of conventional plant and installations to a considerable extent; however, the concentrations to be dealt with are much less than with the treatment of other kinds of waste; and the measurement of quantities of the concentration of 10^{-12} parts per million may be involved. At the Harwell plant the precautions taken include ample capacity of "delay" tanks, to allow decay of radioactivity or its measurement before or after treatment, the provision of pump-operated discharge of effluents, thus obviating any accidental discharges due, for instance, to a faulty valve and the provision of double-bottomed tanks so that leakage can be definitely eliminated.

Many improvements have been made in the design and operation of radioactive treatment works since those described in the papers were brought into operation. Some of the recent improvements, relating to high-activity sources as well as the "probably active" and "possibly active" categories are mentioned by Burns. Much of this work is still hedged about by security regulations and the complete picture cannot be given. But certain interesting facts have already emerged. The use of treatment plant commonly used for trade waste or sewage treatment is one point of interest; it extends, for instance, to the experimental use of such new techniques as sludge freezing. Another concerns the application of such methods to atomic power stations, which would operate on a scale comparable with Harwell, though with a difference in the routine processes. A closed circulation system might be employed in such a case, it was pointed out during the discussion on the papers, with the liquid treated to keep its toxicity within given limits (such a method might upset the accuracy of experimental work at Harwell). The possible siting of atomic power stations would thus be influenced by the efficacy of the treatment of their waste products, which might dictate whether a coastal or riverside site were more practicable. Criticism voiced at the "Civil's" meeting was concerned principally with lack of data on some points, due presumably to security, and a concern for the cost of the Harwell treatment works, which was not stated, but was thought by some speakers to be rather high. The general opinion, however, rightly emphasised the value of the papers, which are the first on a subject which is likely to be of great importance in the future. It is also an occasion when one of the Ministry of Works' civil engineering achievements can be commended, for much of the Ministry's work is carried out under the restrictions of security regulations, and is consequently not well enough known to the profession generally. Trade wastes often present an awkward disposal or treatment problem; in the past many industrial undertakings have been sited with too little concern—or with no concern at all—for the suitability of their sites and of the surroundings for waste disposal. Such thorough attention as the "Civil's" papers give to the problem of radioactive wastes and their treatment is therefore particularly welcome at this stage of the new industry's development.

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

LIFTING EQUIPMENT

SIR,—As a member of a company chiefly engaged in carrying out the regular examination of lifting equipment to comply with the requirements of the Factories Act, 1937, and other statutory requirements, I write to call the attention of manufacturers and users of lifting appliances to a matter which is causing grave concern to our inspecting staff.

There is a growing tendency on the part of designers to enclose as far as possible all working parts of lifting machinery, including many important load-carrying parts which have to be examined regularly. This feature of design is excellent from the point of view of appearance, lubrication and protection, and the guarding requirements of the Factories Act requires such enclosure of working parts. Nevertheless, this has greatly increased the difficulties of surveyors who must examine, according to the Factories Act, 1937, Section 24, "All such parts and working gear . . . whether fixed or movable" at regular intervals. This involves, in many cases, the complete dismantling of machines at great inconvenience to the user.

I feel that this difficulty would be overcome if manufacturers could be persuaded to incorporate suitable easily removable inspection covers on all enclosures containing load-carrying parts of lifting appliances. This would not involve any major modification of design, and would have other obvious advantages in the interests of maintenance. We are advocating this feature of design in our day-to-day contacts with users of lifting appliances with the view that, if purchasers of lifting appliances look for this advantage when selecting their requirements, the manufacturers will hasten to satisfy their wishes.

M. F. BARNES, A.M.I.Mech.E.,
Chief Engineer,
INSPECTING ENGINEERS, LTD.

Birmingham,
October 11th.

E.R.A. Laboratory Buildings at Leatherhead

PROGRESS in the building of the new laboratories of the Electrical Research Association at Leatherhead was discussed by Mr. C. T. Melling, chairman of the council of the Association, at a Press conference on Tuesday last. The laboratories are being built on a 48-acre site at Leatherhead, part of which is at present occupied under lease from the E.R.A. by the terminal station of the British Electricity Authority's 275/400kV experimental line, and the Electrical Development Association's testing station. Briefly, the general scheme consists, first, of a main building to house a number of standard functionally interchangeable "laboratory units," with a library photographic department, conference room and offices; secondly, a separate high-voltage building and, thirdly, a building to accommodate a workshop and a canteen. The main building is a steel-frame and cavity brickwork structure in which the ground floor, second floor and third floor will be of normal height, while the first floor will be 18ft high to suit research work requiring extra headroom, but one-third of this area will be occupied by a gallery and mezzanine floor to give additional working space and observation rooms. This building is in the form of a central section with two flanking wings on the same elevation and with a third wing behind the central section. The high-voltage laboratory building will consist of a central hall, 50ft high, flanked by wings of normal height containing a transformer laboratory, generator and instrument rooms and offices. In the central hall there will be a circular pit to take a large tank for tests under oil. This hall will also house a 3,000,000V surge generator, a 1,000,000V, 50 c/s test transformer set, a high-current surge generator and a high-voltage d.c. equipment. With this installation the Electrical Research Association will be able to participate, for the first time, in the various schemes sponsored by the International Electrotechnical Commission and C.I.G.R.E. for establishing high-voltage test methods and comparing results in different laboratories. The main contract for the building was placed with Gee Walker and Slater, Ltd. in December last and work was started in January. To-day the structural steelwork and floors of the main building are completed and it is expected that the laboratories will be ready for occupation by the spring of 1956. To meet the cost of the new buildings, £400,000, a sum of £100,000 has been set aside from the Association's reserves and an appeal to members for capital contributions has, so far, yielded nearly £197,500. Provided that the total of these contributions reaches £200,000, then the remaining cost, up to

£100,000, will be met by a capital grant from the Department of Scientific and Industrial Research. To qualify for this D.S.I.R. grant a further £2500 is, therefore, required from contributions by members.

North-East Coast Institution of Engineers and Shipbuilders

On Friday last, October 15th, Mr. P. L. Jones gave his presidential address to the North-East Coast Institution of Engineers and Shipbuilders at Newcastle upon Tyne. In his opening remarks the president recalled that he entered the shipbuilding industry thirty years ago and early realised that although marine problems were the more difficult, land installations were operating much more advanced designs of machinery. These included turbines working under high steam conditions compared with the triple-expansion engines and coal-fired Scotch boilers usually installed in ships. During the ensuing years, he said, rapid progress had been made and marine engineering was no longer the poor relation of the engineering industry. These developments, Mr. Jones continued, were the result of private experimental work and, more recently, the research carried out by Pametrada, B.S.R.A., and the N.P.L. To-day, he commented, facilities were available for the full-power testing of both oil engines and turbines, so that performance was predictable. Although the technical advances were satisfactory, Mr. Jones said he was concerned about the shortage of trained engineers, and noted the plans made by many companies to alleviate the position. The general manpower shortage had an important influence, and the lack of entries into certain trades would be felt in the near future. It had already caused changes in design of machinery. This shortage of trained personnel in association with increasing complexity of the machinery created, he said, a serious situation in that the economies resulting from the higher efficiency of the machinery were negatived by lack of skilled staff. The president went on to mention some of the problems in marine engineering which were absent from land installations, such as manœuvrability and reversibility ; the need to operate over a wide range of speed coupled with the avoidance of resonant vibration of the engine itself and of synchronising with the ship, which was an elastic structure. Other problems confronting the marine engineer were the effect of ship movements, restriction of space, ship flexibility, the need to transmit power to a low-speed propeller, and the paramount importance of reliability. Turning to the future, Mr. Jones considered the possibilities of the gas turbine and the development of nuclear power, which, he thought, would be an accomplished fact within ten years, with the heat generated being transmitted more or less directly to the turbine. Such developments underlined the need for solving the personnel problem for, the president emphasised, the prosperity of the country was largely dependent upon the shipbuilding and shipping industries respectively building and operating an efficient merchant fleet.

Books Received

Elementary Fluid Mechanics. Third edition. By J. K. Vennard. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 44s.

Mechanics of Materials. Third edition. By P. G. Laurson and W. Junkin Cox. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 46s.

A History of the School of Engineering, Columbia University. By J. Kip French. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 22s.

Manual of British Water Supply Practice. Second edition. Editor, A. T. Hobbs. Published for the Institution of Water Engineers by W. Heffer and Sons, Ltd., Cambridge. Price 55s.

Statistical Year-Book of the World Power Conference No. 7. Edited by F. Brown. Published on behalf of the Central Office World Power Conference by Lund Humphries and Co., Ltd., 12, Bedford Square, London, W.C.1. Price 40s.

British Transport Commission's Annual Report

The sixth annual report of the British Transport Commission, which was published last Friday, covers the year ended December 31, 1953. Its preface states that " preoccupation with important matters arising out of the Transport Act of 1953 has prevented the report from being submitted as early as is desirable," and it is also pointed out that the Commission's undertaking has undergone radical changes in the past year, the full effect and significance of which cannot yet be properly assessed.

The report shows that the Commission's operations last year resulted in a final net surplus of £4,200,000, after meeting central charges. This surplus compared with £4,500,000 in 1952 and £100,000 in 1951, and reduced the accumulated net deficit since 1948 to £27,300,000. Last year's working surplus was £59,400,000, the report making the comment that traffic on most of the carrying services was greater than in the previous year. The net traffic receipts of British Railways, at £33,000,000, were £4,000,000 lower than in 1952, but the net receipts of British Road Services last year were £8,900,000, which was £7,300,000 more than in 1952. There was, however, a decline of £300,000 to the low figure of £600,000 for the year in the net traffic receipts of the London Transport services, and a fall of nearly £1,000,000 in the net traffic receipts of ships. Last year, the report says, there was a substantial deficiency in the contribution towards central charges from passengers in the London area. This has persisted for several years and must be regarded as one of the major elements in the accumulated deficit of £27,000,000 now being carried forward by the Commission. The explanation, according to the report, is to be found in the fact that the procedure for obtaining increases in fares has involved so much delay that on each occasion the rise in fares has been almost a year behind the rise in costs. The new procedure permitted under the Transport Act, 1953, may provide a remedy, or partial remedy, for " this serious situation." Notwithstanding the net revenue surplus, the Commission describes last year as " disappointing in one major respect." About this, the report comments that the early hopes of financial stability were disappointed, and despite traffics that were fairly buoyant, except in some of the short distance passenger categories, notably in London, the present year opened with the Commission's future budget already unbalanced. Factors contributing to that position were rises in coal and steel prices and in transport wages. In general, the report adds here, increased gross receipts from the principal carrying activities were the result of higher charges rather than of greater volume.

Staff

At the end of last year the total number of people employed by the British Transport Commission was 865,443, which was 15,429 fewer than at the end of 1952. Of that total 593,768 were employed on British Railways, and 94,605 on London Transport. The cost of increased wages and salaries and other concessions granted in 1953 amounted to approximately £7,630,000 in a full year. Wage increases to employees of British Railways accounted for £5,945,000 and to London Transport employees £355,000. The report notes that at the end of 1953 further adjustments of wages and salaries were pending. It is stated that the machinery of negotiation created by the Commission and its predecessors " continued to work effectively in so far as little time was lost during 1953 by stoppages of work." The report comments, however, that there is scope for improving the machinery of negotiation and that discussions to that end have been proceeding with the trade unions.

British Railways

After commenting that, " briefly, the story of British Railways in 1953 is that much the same volume of passenger and freight traffic was handled as in 1952, but that the efficiency with which these traffics were carried showed an improvement," the report refers to the fact that the net ton-miles in 1953 at 22,766 millions were higher than in any peacetime year except 1951. There was an increase of 1·7 per cent over 1952. An appreciable decline in the number of locomotives under or awaiting repair is reported, the relative percentages being 4·9 per cent at the end of 1953 compared with 5·1 per cent in 1952 and 7·0 per cent in 1947. The number and percentage of coaching and freight vehicles under or awaiting repair also declined. It is also stated that the improved condition of the track made an important contribution towards the improvement in operating efficiency during the year, and the number of temporary speed restrictions on trunk lines was reduced. Though permanent way staff continued to be under strength throughout the year, this handicap was overcome to some extent by the use of contractors and imported labour.

During the year £4,100,000 was spent on new locomotives, many of which replaced condemned locomotives having a book value of £1,100,000. In all, 208 new locomotives of all kinds were put into service in 1953, and 426 locomotives—all steam—were withdrawn. Last year's programme of new locomotive building was for 282 engines, of which 227 were to be built in railway shops and fifty-five in contractors' works. The report says that the deficiency was caused principally by the continued effects of the steel shortage.

The capital expenditure on coaching vehicles in 1953 amounted to £9,800,000, and altogether 1136 coaching stock vehicles went into service. About this, the report says that the output fell short of both requirements and workshop capacity and represented a replacement of only 2 per cent or so of the total coaching stock. At the end of the year the accumulated arrears of new building on authorised programmes amounted to 2186 passenger-carrying and 1441 non-passenger coaching vehicles. Capital expenditure on freight vehicles and containers was £21,200,000, the book value of those displaced being £9,200,000. The year's construction of new traffic wagons and brake vans totalled 40,820, which although an improvement on 1952, still fell short of the available building capacity by approximately 12,000 wagons. The total wagon stock increased to 1,122,044, the average capacity per wagon at the end of 1953 being 13·51 tons, compared with 13·34 tons a year earlier.

The total capital expenditure by British Railways on permanent way and structures last year was £6,400,000. Of that £1,900,000 was devoted to running lines and improved drainage and bridge works. In a section on electrification, the report refers to a study of the suburban lines from King's Cross which was inaugurated some years ago. It is now clear that the needs of Hatfield, Welwyn Garden City, Stevenage, Hitchin and Letchworth for better train services are becoming increasingly urgent and that electrification cannot be long deferred. The Commission's decision to put in hand the widening of the existing " bottle-neck " at Potters Bar, moreover, makes it easier to contemplate the more frequent train service which would result from electrification. The report goes on to say that high priority must be given in any plans for further London suburban electrification to this route. Preparation is also in hand of up-to-date estimates, expected to be in the neighbourhood of £34,000,000, for electrification of the remaining Southern Region steam lines east of Reading-Portsmouth.

In a reference to a prototype apparatus for automatic train control, the report states that, last year, fifty-four locomotives were equipped and large-scale trials were carried out. The results have shown the necessity for redesigning certain components to ensure that the apparatus will stand up to the heavy duty required of it. The Commission adds that it does not consider it would be wise to give automatic train control absolute priority over all other devices for

safety. These include track circuiting and improved block control and colour-light signalling on lines of heavy traffic.

British Road Services

Reviewing the development of British Road Services, the report records that the first year (1948) was devoted to planning the organisation from scratch and making a start with the voluntary acquisition of a few score large and well-organised undertakings; the second and third years covered the peak of the programme for the compulsory acquisition of 3288 separate undertakings; the fourth (1951) saw the completion of the acquisition programme and the major part of the difficult task of reorganising the acquired undertakings into a rational pattern; and the fifth year (1952) was devoted to a much needed process of consolidation and to the "running-in" of the services on an economic and efficient basis, the results of which were to be seen in the net traffic receipts last year. In 1953 the organisation was still further developed; regular services now link all main centres, and all important points are connected by teleprinter. More regular working hours have been established, and last year the accident rate showed a marked improvement despite the contrary trend on the national casualty rate.

London Transport

The report records that rising wages and price levels, combined with delay and difficulties in making corresponding adjustments in fares, are reflected in the results of London Transport for 1953. Traffic carried by both road and rail services declined last year, central bus services carrying 37,000,000 (1 per cent) fewer passengers, trolley-buses 17,000,000 (2 per cent) fewer, and rail services 5,000,000 (0·8 per cent) fewer.

Referring to traffic congestion as a factor contributing to the high level of road vehicle operating costs, the report says that the progressive worsening of traffic conditions in the central area of London is a matter for great concern. The deterioration became particularly noticeable during 1953, and the congestion can be traced to two main causes. First, the mounting volume of traffic which seeks to use the streets is outstripping their capacity and, secondly, it is common for vehicles to be parked on both sides of many streets, which would otherwise be able to act as relief roads. Vehicles which might otherwise use them are forced out into main thoroughfares. The report adds that London traffic is slowing down to a rate which produces intolerable conditions at certain times of the day and the cost of the delay and disorganisation thus caused to the public in general and to London Transport road services in particular is becoming increasingly serious.

Docks, Harbours and Wharves

A working surplus of £2,400,000, slightly higher than in 1952, is reported in respect of docks, harbours and wharves. The report comments that this continued the steady trend of improvement which has taken place year by year since 1948, when there was a deficit of £1,300,000. In 1953 all the major groups of docks showed a surplus for the first time since vesting date.

Canals

A deficit of £83,000 from ownership of canals is attributed to the cost of maintaining 850 miles of an evidently uneconomic character, with little, if any, traffic. Of the 2100 miles of waterways owned by the Commission, about 1250 miles, connecting important industrial areas with ports and the coalfields in South and West Yorkshire, Warwickshire, South Staffordshire and South Lancashire, carry about 98 per cent of the traffic. Last year they yielded a net return of about £160,000.

Electronics Research Laboratory in Scotland

LAST week an electronics laboratory at the Edinburgh works of Ferranti, Ltd., which was sponsored by the Ministry of Supply, was formally opened by the Duke of Edinburgh. This occasion and the development and training scheme which it will direct was referred to in our last issue. In the following account we record some constructional details of the laboratory, which we illustrate on this page, and of the principal items in the research and development programme.

There are three floors to the structure, which has a central tower above the entrance hall enclosing the lift and stairways, which give access to the internal corridors. The architectural features, amongst which might be mentioned the extensive use of glass and bare columns, are in accord with contemporary design, as are the internal fittings and colour schemes. The drawing-offices benefit considerably from this treatment, each having a large picture window, 120ft long by 24ft high, which are protected by a decorative metal balustrade running full length.

The internal planning of the laboratories is arranged on a 12ft by 12ft grid, so that there is flexibility in subdivision of the laboratory areas to suit the requirements of any given project. Subdivision of the laboratories is by means of glazed steel partitioning made up in 3ft wide units and rearrangement of this partitioning is comparatively simple.

Ducts to accommodate all services are provided below and above each corridor and are connected with a continuous vertical duct on the inside wall of the laboratory areas. Access to the ducts is gained through flush-fitting duct covers placed at 12ft centres in the corridor floors.

Nine special electrical supplies are separately trunked to a switchgear panel built into the wall in each laboratory. Most of the trunking is made flush with the bench tops to avoid restricting laying space. Each bench has a four-circuit special service plug box and earth terminal, and any of the nine special services can be selected to be used at any bench by a simple wiring adjustment in the switchgear panel. Standard electrical supplies for soldering irons and other miscellaneous uses are available under each bench on a fixed panel holding four sockets. Gas and compressed air supplies are also available in each laboratory, the compressed air being supplied by dual compressors in the powerhouse.

A fluorescent lighting system was evolved to make the laboratory and drawing-office lighting flexible. A continuous vitreous enamelled metal channel is screwed on to the sides of the cross beams which occur at every 12ft throughout the length of the building, and then the fluorescent lighting fittings are slotted into the channel and can be slid into any desired position, the space between fittings being covered with a sprung-on vitreous enamelled plate. The fittings are designed so that either one or two 5ft tubes can be installed, depending on the lighting intensity required.

Heating System.—Steam piped from the main factory to a calorifier chamber on the laboratory site is used to heat the hot water heating system. The building is heated by a series of continuous pipe coils embedded in the ceilings during the course of construction, the total quantity of pipes used for this purpose being approximately 10 miles. Hot water is circulated through the pipes at a temperature of 120 deg. Fah.

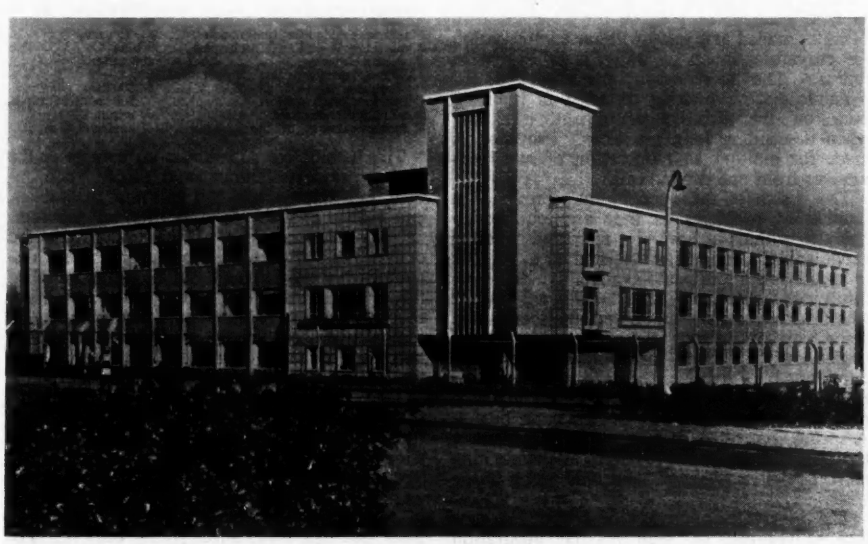
Laboratories.—The laboratory on the ground floor is very largely concerned with work on gyroscopic instruments, and several examples of their application were demonstrated. One of the more important was the gyro gunsight and it was to manufacture this equipment that the Edinburgh factory was built during the war.

During our tour of the laboratories we also saw the company's latest "rate" gyroscope, the example being one which measured rate of angular displacement. In this case the gyro is not free to move, but its movement is resisted so the amount that the gyro axis deflects is governed by the restraining action of the resisting mechanism as well as the restoring force of the gyro itself. As this restoring force is proportional to the rate of turn, the deflection of the gyro axis is a measure of the rate.

The Ferranti rate gyro represents a new departure, in that the gyro frame is not mounted in bearings, but in a cross-spring pivot which provides suspension for the system as well as the necessary restraint. This development provides the instrument with a longer life.

A gyroscope with rotor speeds in the region of 25,000 r.p.m. for miniaturised applications has to be extremely well balanced to promote bearing life and avoid vibration. To determine the dynamic balance of such a rotor a machine was shown based on principles devised by Professor Arnold, of Edinburgh University. The rotor to be tested is mounted with its axis vertical at the free end of a horizontal torsion bar, and with the longitudinal axis of the bar aligned with one plane of the rotor. The rotor is driven at a speed controlled at the natural torsional frequency of the bar. Any out-of-balance of the rotor will tend to twist the bar, the maximum twist coinciding with the instant at which the out-of-balance point on the rotor is at right angles to the axis of the bar.

The amplitude of vibration of the bar is displayed optically on a screen using a beam of light, this light falling on a photocell placed



Ferranti electronics research laboratory

at the point of maximum amplitude. The output from the photocell is used to trigger a stroboscopic lamp shining on the gyro rotor. As the frequency of vibration is well beyond the limit at which the human eye can discriminate, the gyro rotor will appear to be stationary with the out-of-balance point at right angles to the axis of the bar. By referring to a mark on the rotor, the out-of-balance point can be obtained and the necessary adjustments made. The tests are repeated until the rotor is balanced in that plane and there is no bar vibrations. The tests are repeated in one other plane.

In connection with the work on gyros there is on this floor a dust-free room which is also temperature and humidity controlled. All dust particles greater than five-millionths of an inch are eliminated. It contains also a pillar on separate foundations, so that vibration-free measurements may be performed.

The second floor of the laboratory contains the drawing-offices, the standards laboratory, and what has been termed the applications laboratory. One of the items now under development here is an electronic machine tool and process control system.

In the past, most of the work on digital computers has been devoted to devising universal machines capable of doing complex mathematical calculations of diverse kinds. The industrial computer, on the other hand, has to take into account a more limited number of clearly defined functions. Its construction and operation can, therefore, be much simpler because these patterns of logic can be built into it instead of having to be set in by experts for each calculation. In the computer which has been designed here, one of a number of predetermined " programmes " or patterns of logic can be selected at will, and these " programmes " may be modified as required from time to time. This means that each computer for a specialised job need not be a new venture.

In the demonstration a milling machine was shown which will be able to cut almost any three-dimensional shape. The whole system comprises a tape perforator by which the planning engineer instructs the computer to perform the operation required. This involves coding the dimensions of the article, together with machining instructions as perforations on a strip of paper tape. A tape reader transfers the instructions coded on this tape to the computer, which takes this basic information and calculates precisely the movements which the table of the machine tool will have to make to cut the required shape. There is then a magnetic tape recorder which records the instructions for these movements. The machine tool itself is complete with tape-controlled servo-mechanisms and measuring devices, which effect the movements of the table, under the control of the tape playback unit.

The accuracy of the whole control system measured at the slides is within two ten-thousandths of an inch. This is a higher accuracy than the basic milling machine is capable of turning out because of such factors as tool deflection and bearing vibration. In order to utilise the control system fully, special machines which can cut to a much higher degree of accuracy than hitherto will have to be made. The system shown, however, is capable of cutting to at least as high an accuracy as a man can achieve on the same machine, but at a vastly higher speed.

In addition to this machine, a simpler application of the same control techniques was shown in the form of a small drilling machine, illustrated herewith. This has a table which can be positioned to within two ten-thousandths of an inch merely by setting up the required dimension on a group of knobs. In this case, the instructions are so simple that no calculations as such are required, and there is no necessity for a computer. Only a simple addition to this machine is needed to enable it to read the position of a group of holes directly from punched paper tape if it is required to repeat a sequence of holes in an item such as a gear plate.

The second floor is largely devoted to radar development, and one of the principal exhibits was the company's distance-measuring equipment, which is now a standard navigational aid in aircraft. Electronic techniques used in association with this equipment were also demonstrated, including equipment for measuring radio-frequencies and obtaining automatic frequency control to close limits.

Jig drilling machine with electronic control system

The Magnetostriction Delay Line.—One of the factors defining a channel in the distance-measuring equipment system is the relative spacing of the two pulse elements making up a beacon or interrogator transmission. In the beacon the pulse spacing is achieved by using magnetostriction delay lines.

The line consists of a strip of " Permandur " (49 per cent iron, 49 per cent cobalt, 2 per cent vanadium), 30in long by 0·25in wide by 0·005in thick around which are wound two coils, a transmitter coil and a receiver coil, insulated from the strip by Leatheroid fabric.

When a current pulse of between 0·1A to 0·5A is passed through the transmitter coil, the resultant magnetic field causes a momentary expansion of the " Permandur," producing a mechanical stress wave which travels down the line towards the receiver coil. This coil is similar to the transmitter coil, except that it has two small permanent magnets across it, giving a steady magnetic field. As the stress wave passes down the line it causes a momentary change in the permeability of the metal, so that when it reaches the receiver coil it causes a momentary change in the magnetic flux encircled by the coil. This produces a voltage pulse across the coil of between 2V and 8V for the stated current input to the transmitter coil.

The stress wave travels down the " Permandur " strip at a rate of about 1in in 5 microseconds, and so the required delay is achieved by positioning the receiver coil at the appropriate distance from the transmitter coil.

Milled Block Radar Heads.—In conventional waveguides special tubes have been used but, as the dimensions have to be held to close limits, they are costly and difficult to fabricate in complex assemblies, especially in quantity, and small radius bends cannot be readily achieved.

The pieces of equipment that we saw make use of waveguides, but fabricated in a way which enables them to be simply and accurately produced in quantity and provides a strong and easily used and inspected unit. Furthermore, the problem of making small radius bends is overcome. The component is formed from two solid blocks of aluminium. In each block channels are milled in the pattern of the layout of waveguides required, and these channels are made one-half of the depth of the waveguide. The two blocks are channelled so as to be mirror images of each other and when they are placed face to face the complete waveguides are made by the coincidence of the channels. The additional fittings are simply installed and the complete assembly is extremely robust. Once a " master " has been made, further blocks can be rapidly produced by a copy milling technique.

Diesel-Electric Main Line Locomotives for New Zealand

TEN 1500 h.p. locomotives for main line passenger and freight service built recently at the Preston works of the English Electric Company form part of a large order for 1500 h.p. and 750 h.p. diesel-electric locomotives, intended primarily for service on the 425-mile North Island trunk line between Wellington and Auckland. The central portion of this line includes severe gradients, one section having an average gradient of 1 in 60 for 21 miles with 14 miles graded at 1 in 50 without compensation for curvature, much of which is of 7½ chains radius. The locomotives are equipped for dynamic electric braking to assist in reducing wear on the airbrake equipment, especially when descending long gradients. Provision is made for multiple unit operation of two locomotives from one driving cab.

The design of these locomotives presented a number of problems as they are required to operate within a severely restricted loading gauge whilst axle loading was limited to 12 tons to secure maximum route availability. To meet this severe restriction of axle loading a 2-C_0-C_0-2 wheel arrangement was adopted, the locomotive being carried on two three-axle main motor bogies each of which incorporates a two-axle pilot bogie. Tractive forces are transmitted through the bogie kingpins and the drawgear is mounted on the transoms of the main bogies. A spring controlled guiding connection between the bogies is provided to assist in maintaining correct relative alignment and minimising flange wear.

The general arrangement of one of the new locomotives can be seen in the illustration opposite and the leading particulars are given in the table below. The locomotives are required to haul passenger trains of up to 500 tons and freight trains of up to 1000 tons on level track.

Principal Dimensions and Data

Track gauge	3ft 6in
Length over buffer beams	58ft
Overall width	8ft 4in
Overall height	11ft 6in
Total wheelbase	52ft
Rigid wheelbase	12ft
Wheel diameter	37in
Weight in working order	105 tons
Adhesive weight	69 tons
Maximum axle loading (main bogies)	11·75 tons
Maximum axle loading (pilot bogies)	9 tons
Fuel tank capacity	600 gallons
Maximum tractive effort (25 per cent adhesion)	38,500 lb
Continuous tractive effort	27,700 lb at 16 m.p.h.
Maximum service speed	60 m.p.h.
Minimum curve negotiable	4½ chains radius

The locomotive superstructure comprises the underframe longitudinals and transverse members, two side frames, cab and nose assemblies, end pillars and the fixed portion of the roof.

The main members of the underframe are concentrated between the bogie pivots and distribute the tractive and buffing forces applied through the main bogies on which automatic centre couplers are mounted. The main longitudinal members of the underframe comprise two large outer girders of channel section and two inner fabricated girders of rectangular hollow section. This underframe assembly is jig welded then cambered and preloaded before attaching the superstructure side trusses, which are of triangular girder design fabricated from rolled steel and flanged sections.

The load from the locomotive superstructure is transferred to the main bogies through large pivot bearings and helical spring bearers. The bogie side frames are supported by laminated springs with compensating beams between each

1500 h.p. diesel-electric locomotive for New Zealand

pair of driving wheels. Pilot bogies with frames of monobloc cast steel construction are fitted with drop type equalising beams. The load from main to pilot bogies is carried on a large centre bearing and transmitted to the pilot bogie frame by means of a cast steel bolster and side control rocker mechanism. On both main and pilot bogies the centre pivots are provided with phosphor bronze liners on the bearing surfaces. The axle boxes of cast steel are fitted with roller bearings, and the axle box guides are fitted with manganese steel liners on the faces and the cheeks subjected to side thrusts.

The 1500 b.h.p., 850 r.p.m., diesel engine, with the main generator and auxiliary generator form a single unit which is supported on resilient mountings. The engine is fitted with two Napier turbo-chargers, each serving six cylinders. The engine governor, which is driven by one of the camshafts at the flywheel end of the engines, regulates the quantity of fuel delivered by the fuel pumps by means of a servo mechanism operated by the lubricating oil system. The engine is started by motoring the main generator from a forty-eight cell lead-acid battery. Protective measures for the engine include devices which automatically shut down the engine in the event of its speed rising above a predetermined maximum, of the lubricating oil pressure falling below a predetermined minimum and of low cooling water level.

The eight-pole main generator is a d.c., self-ventilated, single bearing machine, provided with separately excited and self-excited field windings, together with a further field winding which is used when the main generator is motored from the battery to start the engine. This main generator supplies current to six nose-suspended, series wound, forced ventilated traction motors which drive the road axles carried in the main bogies. The traction motors are connected in three parallel groups of two motors in series. The auxiliary generator, which is a shunt wound, constant voltage machine, is overhung from the main generator and supplies current for the control circuits, excitation of the separately excited field of the main generator, battery charging, blower motors and locomotive lighting.

The cab mounted master controller incorporates a main control handle, reverser and master switch. The control handle is used to regulate the output of the engine generator set according to power requirements. It has ten notches corresponding to progressively increased generator power outputs, which are obtained by use of engine speeds of 450, 620 and 850 r.p.m. in conjunction with varying degrees of main generator field excitation. The master switch controls the starting and stopping of the engine.

When the control handle is in the tenth notch automatic torque regulation is brought into action, adjusting the excitation of the main-generator so that its output corresponds to the available engine horsepower, irrespective of locomotive speed. Field weakening of the traction motors is automatically obtained as a function of the previously mentioned automatic device having reached its position of maximum travel, corresponding to maximum field strength of the traction generator.

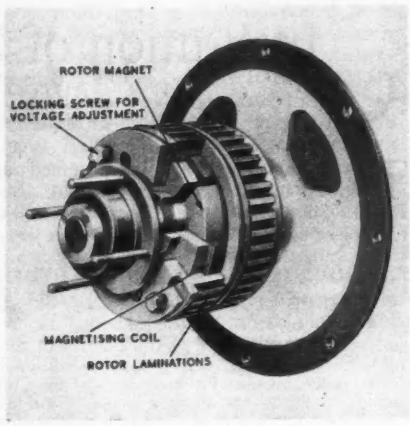
During dynamic braking the traction motors generate current which is absorbed by resistances, the motor fields having been disconnected from their respective armatures and reconnected in series to the main generator. Excitation of the traction motor fields during dynamic braking is obtained from the output of the main traction generator and is controlled through the excitation of the main generator field. Increases in excitation of the main generator field result in increased current flow through the traction motor fields and consequently increased dynamic braking effort is produced.

High-Frequency Inductor Alternator

A SMALL high-frequency inductor alternator has recently been developed by the British Thomson-Houston Company, Ltd., Rugby. The excitation of this alternator is provided by a permanent magnet instead of a d.c. field winding and the machine is independent of external supplies.

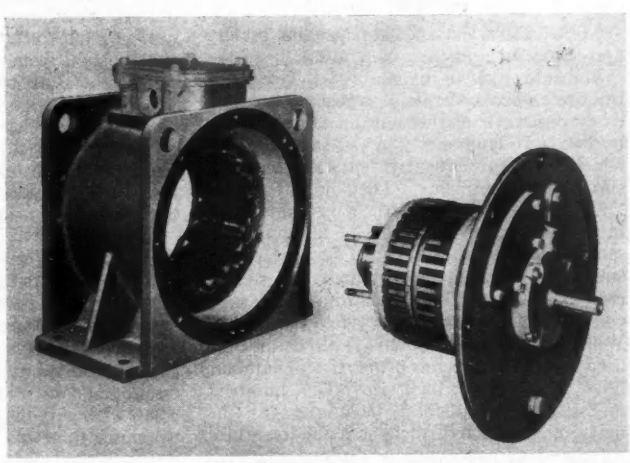
The alternators at present being built have a continuous output rating of 250VA, 115V, 1600 cycles per second, at 2400 r.p.m. They are totally enclosed, water-tight up to the shaft level and are fully shock proof. A machine of comparable physical size with a ventilated enclosure would be capable of outputs of up to 1kVA.

The accompanying illustrations show the general construction of the alternator. Briefly, the machine is a homopolar inductor alternator with an annular magnet of "Alcomax III" incorporated in the rotor with a rotor shaft of non-magnetic steel. A magnetising coil is wound over the magnet, the coil ends being brought out to terminals mounted on the rotor end-flange; during manufacture, a current of about 100A is passed momentarily through this coil to magnetise the rotor in an axial direction.



Cut-away view of rotor showing the permanent magnet and the magnetising coil whereby the rotor can be remagnetised after repairs

A characteristic of the design is that the rotor may be removed from and replaced in the stator without loss of magnetism. However, if the rotor itself is dismantled, it must be remagnetised after reassembly, but this can be done easily by using the coil provided, without the need for any special jig. Tests made by the manufacturer show that the rotor magnetism is not affected even when very severe short circuits are applied to the output winding, for example, by short circuiting through a series capacitor which resonates with the winding inductance at the operating frequency.



Rotor withdrawn from stator of inductor alternator. The rotor can be removed from and replaced in the stator without loss of magnetism

Provision is made for sufficient voltage adjustment to cover variations in manufacture and materials by varying the angle of offset between the teeth of the two rotor cores. As usual with high-frequency alternators, a capacitor is connected in series with the alternator winding to improve the load regulation characteristic; with such an arrangement, the regulation from full rated load to open circuit may be as low as 20 per cent.

This new machine was designed initially for use as the pilot exciter of a turbo-alternator set with "Magnestat" automatic voltage regulation, the permanent-magnet alternator providing the magnetic amplifier with a conveniently high frequency supply to allow small physical size and high speed of response in the amplifier. It is also suitable for many applications where very close voltage regulation is unnecessary, or where the load only varies over a small range.

Institution of Naval Architects

AUTUMN MEETING

No. IV—(*Concluded from page 517, October 15th*)

THE autumn meeting was resumed on Friday morning, September 24th, Mr. R. B. Shepheard in the chair, with the reading of paper No. 5, which was :—

EXPERIMENTS WITH A LOW DRAG HYDROFOIL

By R. L. Townsin, B.Sc.

Synopsis

This paper describes the main body of the work carried out during the author's tenure of the first Froude Research Scholarship, as an advanced student of King's College, Durham University. The work was carried out under the general supervision of Professor L. C. Burrill and the experimental tests, which were made in the Ship Division of the National Physical Laboratory, were supervised by Dr. J. F. Allan.

(1) A symmetrical hydrofoil was designed and made with sufficient care for it to achieve a laminar boundary layer over 60 per cent of its surface.

(2) The drag of the hydrofoil with various boundary conditions and at zero angle of incidence was measured in a towing tank by Pitot traverse and check drag measurements were made by an alternative method.

(3) Streamflow observations were made for all conditions of the hydrofoil.

(4) The drag of the hydrofoil was calculated at zero incidence for various Reynolds numbers and transition points.

Discussion

Mr. A. Silverleaf : This paper has brevity and some very positive conclusions.

I would like to expand Mr. Townsin's brief reference to the only previous attempt to carry out work of this nature. It was done by two aerodynamicists in the same tank in which he subsequently carried out his successful experiments. Their hope was that " if the test were successful a valuable technique for the investigation of laminar flow sections would be established because of the simplicity of drag measurement and of the ease and accuracy with which models can be cut in paraffin wax." They felt that " The William Froude National Tank cannot be used to investigate the properties of laminar flow aerofoils at high Reynolds numbers unless an experimental technique can be devised, for which disturbances due to surface wave and eddy formation do not matter." They said their failure was due largely to early transition caused by wall disturbances. Mr. Townsin has not only succeeded, but has given a true explanation of how they failed.

So far as the detailed results are concerned, I think almost all the results given in Fig. 7 show excellent agreement between calculation and experiment and between various methods of experiment. This work has shown fairly conclusively that laminar flow sections are impracticable in ship service conditions. An important consideration is whether laminar flow hull forms can be devised and used, but I do not think this paper throws a great deal of light on that.

So far as propellers are concerned, it reinforces some conclusions which we have also reached, in the same tank. The work gives a clear guide that we cannot expect to use laminar flow sections in propellers for the purpose of improving efficiency, but we can expect to apply them usefully, as we do, from other points of view, particularly cavitation delay.

Mr. Townsin is optimistic in his belief as to the fine finish on the surface of propeller blades after they have been in service for some time. Even under the best conditions they develop a roughness which I think would be in itself sufficient to trip the flow. I will add a further practical conclusion, of which I think he is well aware, that ships and propellers are not the only bodies which travel through water, and the conclusions will have practical value for those interested in torpedoes.

Mr. H. Lackenby : In Fig. 7 Mr. Townsin shows curves where the transition points are varying from 20 to 67 per cent. Would he show also the curves for 0 and 100 per cent. I think he should get some information on form effect, which is very much with us in these days.

Professor E. V. Telfer : We began this meeting with a direct tribute to Froude in Dr. Gawn's paper. In the second paper, by Mr. Lackenby, we had the development of the geosim method which Froude started in 1867. Then we had the paper by Dr. Brown on the accurate measurement of power, and that by Professor van Lammeren and his colleagues showing the geosim approach, again a development of Froude's work. Now we are discussing Mr. Townsin's paper, and he is giving us the first report of a Froude Scholar of this Institution. The last paper to be presented here is that by Mr. Doust on the side launching of ships ; and Froude also put his mind to the launching of ships. As a development from this meeting I suggest that we should establish a Froude Medal, which will be a continuing and repeating tribute to him ; further, in view of the high genius of Froude himself, it should rank with the senior medals throughout the world of science and should be competed for by the best brains in naval architecture.

I agree fully with Mr. Silverleaf that this paper has practical findings and conclusions. But I feel, in connection with Fig. 7 that he might improve the presentation considerably by realising that the device of the total wetted surface is one which was introduced by Froude himself and which we have developed very much in naval architecture. That changes the picture, because whilst we think in terms of form effect ourselves, it is a form effect plus resistance plus unit wetted surface ; the form effect here includes the effect of wetted surface over twice the chord length, and it is important to realise that every piece of wetted surface adds to the total resistance of the flow.

Again, on the line of making ourselves a little more independent of the aerodynamic side, I suggest that in an appendix to the paper he might give a brief outline of Dowlen's method of calculating the resistance. I think that would add to the value of the paper and would help others by indicating the usefulness of that method.

In connection with the practicability of laminar flow on ship forms, we find when we test very small models that, whereas we can get very low resistance at some speeds, very often at lower speeds, the resistance shoots up to an enormous figure, and that type of laminar separation is due to the inability of the pressure on the outer body to recover. There is no need to have laminar flow throughout the length of the model, because it appears certain that in the after body, where pressure recovery is so important, the laminar flow forbids pressure recovery. It is therefore better to have laminar flow to a partial extent and encourage the flow in the after body to be turbulent, to produce the best possible pressure recovery.

Mr. L. Woollard : The paper indicates that the prospect of getting laminar flow is not rosy so far as ships are concerned, but this work is valuable in giving some negative results, for it shows where we should not try to use it in the future and where it may become suitable.

Dr. E. C. B. Corlett : The author discusses the possibility of obtaining laminar flow on brackets, propellers, &c. Professor Gray, of Cambridge, who is a biologist, has done some rather interesting work on fish and there is reason to believe that the e.h.p. applied by fish is far greater than the power output of the muscles. It appears that the power output from the muscles of any animal is constant. The scale of fish is pretty rough, and on the top of the scale there is a mucous film which is clearly to reduce the roughness coefficient. But even making allowance for that, one still cannot reconcile the e.h.p. figure suggested as the possible power output of the fish. Is not this an attempt by Nature to produce laminar flow over a portion of the body ?

Commander (E) Peter DuCane : Other speakers have raised the point as to whether or not we should get laminar flow on a hydrofoil. This applies to the sub-surface of a submerged foil, and surely the whole of the pressure recovery would be different from that of a foil which breaks the surface. It has always seemed to me difficult to know what to call these hydrofoils, aerofoils, &c. Could it possibly be arranged that we have some better overall term ?

Professor E. V. Telfer : Recently a paper was published on the testing of a model in two halves, the one half independently of the other. The after half was almost zero. The flow around that part of a ship is squeezing in and propelling the ship forward ; it has a better pressure restoration, and the better pressure restoration you can give to the after body the better the result. I think that is one of the things which gives the fish a perfect pressure restoration mechanism. Some biologists feel that from the mouth to the gills of a fish there is also an element of another propulsive mechanism. The fish tries to swallow and there is pressure out of the gills in the normal way of feeding, a pressure balance which further helps to propel the fish. I do not think a fish really tries to get laminar flow. Nature has provided an entirely different method of providing the fish with propulsion.

The second paper presented on the morning of Friday, September 24th, was the sixth and final paper of the autumn meeting of the Institution of Naval Architects at Torquay, and was :

SIDE LAUNCHING OF SHIPS—WITH SPECIAL REFERENCE TO TRAWLERS

By D. J. Doust, B.Sc.

Synopsis

Over the past few years an investigation into the side launching of ships has been in progress at the Ship Division of the National Physical Laboratory. Ship launches have been recorded by means of gyroscopic equipment placed on board and wired to recording units on shore. Continuous records of the roll, pitch and yaw of many vessels were taken during launching, together with the motion down the ways. A series of model experiments has been conducted with a trawler model, in which the main factors affecting side launching were systematically varied. From this work a method has been developed, using design diagrams, to enable launching characteristics to be predicted in advance, with practical accuracy. Two ciné films showing aspects of the work on model and ships have been prepared. Further experiments are envisaged for other ship types, with a view to extending the range of the design diagrams.

After the presentation of the paper, a

film was shown which demonstrated the side launching of model hulls and the full-scale side launches of trawlers.

Discussion

Mr. A. Hiley : This paper is of extreme value, particularly in connection with the calculated and observed behaviour of actual ships and the investigations made on models, using delicate apparatus for the measurement of velocities and the angles of heel, the investigation of the effect of the radius of gyration and moments of inertia. The work might be extended to see the effects of water on the way ends. The behaviour of several ships when side launched has been recorded accurately, and we know that further investigations can be conducted in this way to improve anything that it is possible to improve. The paper is almost to be regarded as supplementary to the informative treatment of the side launching problem on the Great Lakes by Mr. James Fahey, published in 1942. He also connected the results thoroughly as between model and ship, and dealt with the launching of submarines and also of very long ships of very restricted width.

Velocity has been recognised as a very important factor, and in the paper the velocities are shown on an abscissa of metacentric height. Perhaps a little further information might be given in future as to what would be the effect of producing curves which, on a base of travel beyond the way end, would represent the angle of heel and trajectory of the ship as she continues and falls over the ways. I think, however, the base taken in this paper is in agreement with Mr. James Fahey's treatment of the subject. Some assistance might be given at a yard where a barge or ship of this type has to be launched in a restricted width of water by arranging the declivity of the ways so that there will be an increasing decline as the vessel reaches the way end.

The 1000-ton deadweight barges of the first world war had the same length as the trawler mentioned in this paper (180ft) and the other dimensions were the same, but they had twice the displacement at the launch, i.e. more than 800 tons. It was necessary to avoid damaging the bottoms of those ships as they passed over the way ends, and it was necessary to have a considerable amount of water on the way ends, at least 1ft. I arranged the launch and had to deal with a velocity over the way ends of 16ft per second, against the average of 10ft per second in this paper. The vessels came to rest with an angle of heel not exceeding 15 deg., which is moderate. In a test it was necessary to push the vessel forward so that she did not hesitate on the ways, and she went over with a marked increase of velocity. That was done by applying pressure behind compressible pads consisting of soft wood.

I have arranged a model of a brake which Mr. Doust might find will control a ship when side launched. It consists of a hawser passing through a brake drum. The hawser could be connected with the upper part of the ship, and brought into action at a given stage in the launching ; the hawser can be allowed to pull through against a given resistance, which could be kept to a regulated value. It will prevent any unwanted stresses being introduced, and the vessel can be brought to rest at a short distance from the way end. I think it could be applied with great advantage in restricted waters, whether the launching is end on or otherwise. It would give full control of any ship, even a long ship, in a river like the Tyne, where you might have to pull up a ship 100ft after leaving the launchways.

Mr. King : With regard to Table I in the paper, showing the comparison of ship results with model predictions, there are points which intrigue me concerning trawlers Nos. 4 and 6. In both cases the equivalent G.M. is very high as compared with the basic trawler 1, and yet there is a great variation in the maximum outward angles of roll, 28·0 and 32·25 respectively, whereas the maximum return angles of roll do not show such a great variation for the two vessels. In view of the slightly increased velocity and the much higher equivalent G.M., can he explain just why these differences do not tally so well with trawler 1. Another thing I noted was the difference in static drop as between trawlers 4 and 6 (3ft 7in and 4ft 3½in respectively). Would that mean that the difference in static drop would have a greater effect on the angles than the G.M. of the ships, particularly as trawler 6 has such a high equivalent G.M. (7·05ft)? Would it be a fact, apart from any braking apparatus or anything to check the angle, that a high G.M. of the vessel when leaving the ways and entering the water (before it is fully waterborne) has no effect at all or very little ? It appears to me here that the question of static drop is far more important than G.M. Would an increase in the declivity of the slip, without actually lowering the slip at the water end, be effective in virtually reducing the static drop and therefore bringing the outward angle considerably lower in the other case ?

Mr. Ambrose Hunter, in a letter, which was read by the secretary of the Institution, said :

" Cook, Welton and Gemmell had successfully launched sideways for upwards of fifty years. With increase in dimensions, change in form and the limitations of the River Hull, it was felt that the mechanics of sideways launching should be studied. The results of the research undertaken by National Physical Laboratory do enable successful sideways launching to be arranged for all conditions of constructional progress, weather conditions and level of tide. Records continue to be taken of sideways launching at the Beverley shipyard with a view to the information obtained being correlated to further model research by National Physical Laboratory on other types of ships. By this means it is hoped to establish clearly the upper practical limit of production from the Beverley shipyard."

Captain Harold E. Saunders, U.S.N. (Ret.) : For side launches of this kind it is most illuminating to have a step-by-step picture of what happens in a transverse plane, beginning at the instant the centre of gravity passes the way ends. What the writer has in mind is a diagram like that at the top of Fig. 8 (*b*), but drawn to a much larger scale, showing the actual positions of the ship section at equi-different time intervals Δt. Such a diagram indicates not only the minimum bed clearance under the low bilge (or bilge keel) at the first roll outward, but the amount by which the trailing bilge (or bilge keel) clears the way ends when the ship rolls back towards the building slip. It also shows the obliquity of water impact under the hull for the side launch of a vessel with a large rise of floor. The author's proposal to fit gauges and take pressure measurements on both model and ship is considered excellent. It would be possible, from the sequence diagram I have mentioned, to tell just which part of the bottom hit the water first and where to place the gauges.

Mr. Doust, replying to the discussion, said :

The possible extension of the length of vessels needs further investigation. It is quite on the cards, and there is no reason why it cannot be done. His use of a compressed block to give a high starting velocity in launching, applying the principle of residual strain energy, as I understood him, is most illuminating, and it is something to be followed up by those in the industry. Similarly, the use of the cable passing through the brake drum, giving very accurate control of the motion and absorbing such a lot of the energy which has to be dissipated, will have an application not only to side launching, but to end-on launching, because we have all had experiences where the use of drags to arrest motion not only tears up the shipyards, but is a source of considerable danger to personnel.

Mr. King raised a very interesting point. The vertical height of gravity has two effects on the subsequent motion. Gravity affects the motion at the way end. Obviously, if you have a higher centre of gravity you have a higher moment at any instant and generally the rotation would be increased. But an additional effect is a dynamic one, in that when the vessel is in the water there is also a higher centre of gravity for constant height of metacentre ; that involves a reduced metacentric height, and there is a further loss of velocity. I am glad that Captain Saunders endorsed our proposals to use strain gauges on both ships and models, and we shall no doubt proceed on the lines suggested by him.

Department Store at Coventry

We have received details of the large department store recently built for Owen and Owen, Ltd., at Broadgate, Coventry, which was opened on October 1st. The store has five sales floors, giving a total area of about 100,000 square feet, and seven stock and office mezzanine floors ; its exterior is faced with brickwork, travertine and orange-red briquettes, arranged in a design of handsome proportions.

The structure of the building, with which the following brief note is concerned, is of reinforced concrete. The main superstructure contains two forms of construction. In the sales area flat slab floors are supported by mushroom columns on a 27ft 6in grid, and in the stock mezzanines normal beam and slab construction is employed. An unusual square tapered form has been employed for the columns supporting the flat slab, in which the architects proposed the use of a tapered form for both shaft and table, encompassing the shaft, cone and table dimensions required by the British Standard code of practice. The exact profile was determined by cardboard models which allowed the study of the diagonal proportions which were considered much more important than the elevational profile. Both functionally and æsthetically, we are informed, the new form has been a great success.

For the construction of these columns, pockets of a depth sufficient to accommodate the bond length of the column reinforcement were formed in the head of the column underneath. Into these pockets the column reinforcement was inserted, thus dispensing with the need for splice lengths of reinforcement and avoiding congestion of steel in the reduced section at the feet of the columns.

It was originally intended that the external concrete walls would be permanently shuttered internally with cementitious wood wool slabs and externally with facing brick, where used. The lower ground floor was lined in this way, but experience showed that almost as much shuttering was needed to prevent movement in the slabs as would be required for normal working. Similarly the use of half brick lining externally was dropped owing to the small lifts possible and to the consequent slow progress.

The majority of the external walls are constructed of reinforced lightweight concrete of 90 lb per cubic foot density. This method gave

the required insulation and provides sufficient strength to resist wind loading on an unsupported height of 15ft 9in between floors. The brickwork was added later, the concrete first being painted with bitumen.

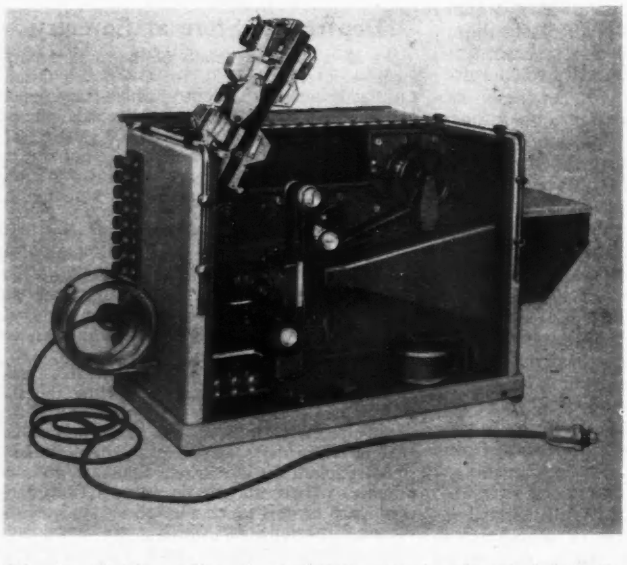
The building was designed by R. Hellberg and M. Harris and Messrs. Scott and Wilson, Kirkpatrick and Partners, the architects and consulting engineers, respectively. The main contractor was Bovis Ltd.

Stylus Oscillograph

A STYLUS oscillograph capable of simultaneously recording up to eight electrical quantities has been developed by the Compagnie des Compteurs, Paris, and is being distributed in this country by Parkinson and Cowan Instruments, 7–17, Fitzalan Street, London, S.E.11. The oscillograph, the "OSL 81," uses specially prepared 35mm film, and moving iron measuring elements. The torsion bar suspension employed gives linear response from 0 to 700 c/s, immunity from drift and high inherent damping. A triangular shaped, light alloy arm is secured at its base to the moving-iron section. Mounted at the tip of the arm is a stylus of hard material, which inscribes the record on the film. Provision is made for the adjustment of stylus pressure and arm alignment.

Owing to the high driving torque and the low moment of inertia of the moving section, the resonant frequency of the element is very high, being of the order of 800 c/s. Each measuring element consumes 0·8W d.c. or 0·4W a.c. for a nominal deviation of 0·5mm.

The standard element range available extends from 75V, 10mA to 0·75V, 1A. Elements are fully interchangeable and may be fitted in any combination. The range may be extended in the usual way by means of transformers or resistance shunts and multipliers.



Side view of stylus oscillograph, showing the measuring elements (raised), the film magazine and the start/stop push button on lead

A marker element on the same framework as the measuring element gives a simple on/off indication on the film, e.g. to indicate closing or opening of contacts.

The non-inflammable recording film has deposited on it a very thin layer of black varnish, upon which the trace is inscribed. The film is of standard 35mm dimensions, which enables the records to be examined with any normal film projector.

The varnish layer is sufficiently thin for the film to be handled without special precaution and is soft enough to reduce stylus friction to a minimum, The trace produced on the blackened surface has a uniform width of 0·01mm with a maximum amplitude of 1mm, and can be viewed immediately after recording by employing the built-in enlarger. This projects the record on to a ground glass screen at the front of the instrument and gives a magnification of five times. Further magnification can be obtained with optical apparatus up to fifty times, without loss of definition. The high degree of enlargement is made possible by the fineness and regularity of the trace.

After the film has been traced under the styli it passes through a slot at the rear of the instrument into a magazine. During examination of the record the film is fed back into the oscillograph. A film cutter built into the magazine can be used to cut off completed sections of film record. A spool of special film is about 24m in length, giving a running time of forty minutes at the slowest film speed of 1cm per second. For permanent storage the traced film may be fixed by spraying with diluted cellulose varnish.

During operation the film is started and stopped by means of a push button on a wander lead, and controls are fitted to the front of the instrument to change from the recording to the observing condition and also to advance and reverse the film during examination.

Depending upon the frequency of the variable to be observed, the running speed of the film may be varied in set steps of 1cm per second, 2cm per second, 4cm per second, or 8cm per second by changing the position of the mains input plug.

Institution of Structural Engineers Presidential Address

ON Thursday, October 7th, Dr. S. B. Hamilton was installed as president of the Institution of Structural Engineers ; in his presidential address he spoke of the historical background of development of the professional civil engineer, and of the development of engineering education in this country, these remarks leading to some comments expressing Dr. Hamilton's opinions on the efficiency of examinations, and on the education of professional engineers. The emergence of the professional civil engineer was first apparent in France, Dr. Hamilton noted, but in Britain civil engineering was hardly organised at all until the nineteenth century. One of the facts brought out during the course of his address was the tardiness with which a formal technical education was introduced into British scholastic life. London gave its first B.Sc. degree in 1860, he noted, and its first B.Sc. (Engineering) in 1903. The "dead hand" of Plato, even after two millennia, had a firm grip on the academic world, he said, and intellectual snobbery still looked askance at any intrusion by professors of the "base mechanic arts." Dr. Hamilton continued by describing, in outline, the history of the Institution of Structural Engineers, after which he commented on the valuable work done by its education committee. These remarks led on to a review of the aims of present-day education, and of the efficacy of examinations and "professional intrusion," on which subjects Dr. Hamilton made some pertinent observations. Although he did not suggest that the study of arts subjects should be discouraged, he thought that it was pathetic to see so many of the most promising young scholars urged by their headmasters to pursue lines of study which could, at the end of the university course, prove vocationally "dead ends" ; there was a grave danger, he continued, that because far too few graduate teachers of science in sixth forms were available, the supply of technologists and scientists might be strangled at birth.

Dr. Hamilton went on to point out that some teaching institutions had attempted to "humanise" scientific and technical courses, which alone could not give adequate training, by inserting into the curriculum classes in such subjects as English literature or philosophy. He was doubtful whether such insertions would be successful in their aim, but there was an alternative which seemed to him much more promising, namely, the study of the history of the main subject of the course—science, engineering, building, or the like. Such a study raised with it, Dr. Hamilton contended, questions which carried enquiry far beyond the original subject matter. He did not suggest that history should be a subject of examination for engineers, but its study, he contended, would have far-reaching beneficial consequences, and go far to provide the liberal element in technical courses, the absence of which was often, and not unjustly, deplored.

Instruction and study, however well conducted, Dr. Hamilton concluded, could never make an engineer. Experience was equally necessary and important. That fact was borne in mind by the Institution's membership committee ; a membership 7000 strong had been built up, he noted, and the Institution was fully equipped to provide structures which might compare not unfavourably with the achievements of our great forerunners.

Titanium Production

LAST week Imperial Chemical Industries, Ltd., held a conference, which was attended by representatives of the British aircraft industry, to discuss the properties of titanium and its alloys, handling and jointing problems and availability. During the conference melting and preliminary fabrication were demonstrated in a pilot plant, corrosion test specimens inspected as was a large scale melting plant under construction.

Several years ago the General Chemical Division of the company started research on the metal and investigated many processes with the result that by the process of elimination it was decided that reduction of titanium tetrachloride by sodium was the most promising, especially under British conditions. This method proved likely to give good-quality material at a price competitive with that of material from other processes, so that most of the company's effort is directed now to the reduction of titanium tetrachloride by sodium, although it is operating a titanium plant using the Kroll process, which uses the magnesium reduction technique. Originally it was thought that the sodium reduction reaction would not be controllable on a large scale and that the titanium sponge produced by the process would not have the property of allowing good-quality massive ingots to be made, but the work in the company's laboratories had proved otherwise. The results obtained from a semi-technical plant, built in 1953, and a larger pilot plant which started operations early this year, have confirmed the early work both with regard to the quality of the product and the efficiency of the process. Imperial Chemical Industries, Ltd., felt so confident of the outcome of the early tests that it commenced building a large-scale sodium process plant towards the end of 1953, and it is planned to bring some units into production early in 1955 and to be in full production by the summer of that year.

The product from the pilot plant is in the form of granules, which can be compressed into pellets for melting and thence into ingots, and the plant has been melting raw titanium sponge at the rate of 150 tons per annum and converting it into ingot, forging stock and fabricated products. The full-scale plant is designed for a capacity of 1500 tons per year, but provision has been made in the design to allow for expansion to meet possible higher demands for titanium.

COAL PRODUCTION.—Coal production in Great Britain last week amounted to 4,616,300 tons, of which 4,403,600 tons came from deep mines and 212,700 tons from opencast sites. In the forty-one completed weeks of this year up to last Saturday, saleable coal output amounted to 175,575,700 tons, which was 1,345,400 tons in advance of the quantity produced in the comparable period of last year. Deep-mined output this year is now nearly 3,000,000 tons more than in the corresponding period of 1953. On the other hand, in the first forty weeks of this year coal imports totalled 1,685,600 tons, against 331,200 tons in the corresponding weeks of 1953.

Passenger and Motor-Car Ferry "Mons Calpe"

RECENTLY the passenger and motor-car ferry "Mons Calpe" successfully completed her trials. The ship was built at the Troon yard of the Ailsa Shipbuilding Company, Ltd., for the Bland Line, Ltd., of Gibraltar, under the supervision of Watts, Watts and Co., Ltd., to meet the requirements of a passenger, mail, car ferry and cargo service between Gibraltar and Tangier. This route is extensively used by those wishing to visit the North African international seaport of Tangier, and the ship has been designed with the object of making a fast and comfortable crossing.

The main particulars of the new ferry are as follows :—Length overall, 283ft ; length on the load water line, 268ft ; breadth moulded at the car deck, 48ft ; breadth moulded at the load waterline, 45ft ; depth moulded to car deck, 17ft ; depth moulded to shelter deck, 26ft ; maximum mean load draught, 10ft 6in, and gross tonnage, 2000. Provision has been made to carry approximately seventy motor-cars and there is accommodation for 600 passengers. The ship, which is mainly of riveted construction, has been built under the survey of Lloyd's Register of Shipping and conforms with the latest regulations of the Ministry of Transport. The main or car deck extends for the full length of the ship and above it is the shelter deck, which extends from the bow for a distance of about three-quarters of the length of the ship. There is a lower deck forward and aft of the machinery space and the erections above the shelter deck consist of the boat deck and the navigating bridge. Subdivision is effected by a total of eight watertight bulkheads.

The passengers are mainly accommodated on the shelter deck where, at the forward end of the deck house, is a dining saloon which extends for the full width of the ship and seats 110 persons at tables for two, four and six. Quilted maple, sycamore and "Warerite" have been used for lining the bulkheads and the latter material forms the table tops, while the chairs are upholstered in red leather. A wide entrance hall and purser's office separates the dining saloon from the lounge and cocktail bar, where the dado is of Nigerian pearwood with green Finaweave above. The room is furnished with small tables with "Warerite" tops and has seating accommodation for fifty-two persons. Open deck space for the passengers is available forward of the deck house, abreast and aft of the lounge and is equipped with buoyant seats.

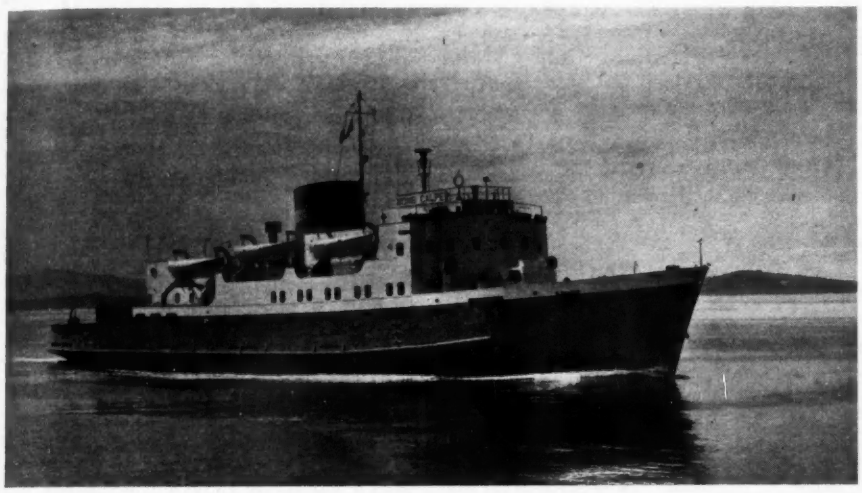
Comfortable accommodation has been provided for the officers and crew, the deck officers and engineers being housed in single-berth cabins in a house on the boat deck, while for the crew there are one, two and three-berth cabins at the forward end of the main deck and on the lower deck forward of the motor room. The crew's mess is located on the lower deck and, on the same deck, but aft of the engine room, is their recreation room. Except for the crew accommodation forward practically the whole of the main deck is allocated for the stowage of motor-cars, which are taken on board from the piers, by means of adjustable ramps, through doors to port and starboard at the forward end of the deck and hinged bulwarks at the aft end. Two turntables assist in handling the cars. A small hatch at the aft end of the deck gives access to a hold for general cargo.

Below the lower deck are dry spaces except the compartment immediately forward of the engine room, where the sewage plant is mounted. The deck machinery consists of an electric windlass, supplied by Clarke Chapman and Co., Ltd., to take 1 1/16in diameter "Tayco" anchor cable and a 3-ton electric capstan provided by Thomas Reid and Sons (Paisley), Ltd. Manœuvring of the ship is effected by twin-spade rudders operated by electric hydraulic steering gear manufactured by John Hastie and Co., Ltd. Ventilation of the ship is by mechanical means and for heating the various spaces a hot water radiator system is installed. There is a fully equipped galley on the lower deck forward which has electric range and other cooking appliances and a lift for the service of meals to the dining saloon on the shelter deck.

A total of six lifeboats is carried, including four of 28ft in length and two of 26ft in length. Two of the 28ft boats are carried in overhead gravity davits, the remaining four boats being carried in deck-mounted davits. Fire-fighting arrangements have been designed to meet the unusual conditions and design of the ship, and the navigational aids include radar, a direction finder, and an echo sounder; there is a broadcasting system to the public rooms and generally throughout the ship.

In the engine room are installed two British Polar "M 47 M" diesel engines, each having seven cylinders of 340mm diameter by 570mm stroke and developing 1310 b.h.p. at 300 r.p.m., and capable of giving the ship a speed of 16 knots. The four-bladed propellers, supplied by the Manganese Bronze and Brass Company, Ltd., are of Scimitar design, have a diameter of 7ft, and weigh slightly more than 1 ton each.

Among the auxiliary machinery are two Reavell air compressors, one being motor driven and rated to deliver 50 cubic feet of free air per minute at 350 lb per square inch, and the other being driven by a Ruston and Hornsby diesel engine and rated to deliver 45 cubic feet of free air per minute. Most of the pumps are of Drysdale's manufacture. They include a fuel oil transfer pump of 3 tons per hour capacity against 50 lb per square inch ; two lubricating oil pumps of 58 tons per hour against 50 lb per square inch, plus 10ft ; two fresh water circulating pumps rated at 95 tons per hour against a 30ft head ; a salt water pump and two general service pumps of similar capacity ; an emergency fire and bilge pump of 50 tons per hour rating and a domestic fresh water pump and a sanitary pump, both of "Wee Mac" pattern and of 570 gallons per hour capacity. A Sharples fuel oil purifier, a lubricating oil purifier and a Victor oily water separator are also fitted.



Passenger and motor-car ferry "Mons Calpe" on trials

Radial Arm Equipment for Gauging Railway Structures

A DEVICE for measuring the clearances between rails and structures has recently been designed by the civil engineering staff of the Eastern Region of British Railways. Its use is claimed to reduce to a minimum the time during which the gauging train occupies the track, an obvious advantage in railway operation. The device is mounted on a rail vehicle, as shown in the illustration ; it consists of : (*a*) The radial arm assembly comprising a carrier beam, a graduated disc and a telescopic arm ; (*b*) the pedestal upon which the radial arm is mounted, and which registers with the running edge of the rail at the position where clearances are to be measured ; (*c*) warning lights for protection ; (*d*) a cabin also on the rail vehicle, arranged for the use of the assistant who records the measurements taken.

When measuring the clearances of a structure, the vehicle is brought to rest opposite it ; the radial arm of the gauge is then attached to the spindle of the pedestal, and the pedestal lowered and adjusted until the running edge of the rail is engaged by the rail stops. The radial arm is then rotated and the telescopic arm extended to touch the structure at the various points it is required to measure and the resultant angles and dimensions read on the graduated disc and linear scale.

Each division on the disc represents 1 deg. The index arm for reading the angular measurements is provided with two marks, the right-hand one normally being used. The carrier beam rotates with the disc and the angles are read at this mark. When, however, the carrier beam is in the vertical position or is approaching

Radial arm gauge used on the Eastern Region of British Railways for measuring the clearances between structures and rails, with minimum time of occupation of the track

this position, one of the marks on the index arm, together with a portion of scale, are obscured by the arm. For this reason a portion of the scale is repeated (beneath the main scale) and readings can be taken at whichever mark is visible. Radial distances are measured by traversing the tubular portion of the radial arm through the rollers by handles, until the pointed end is within a few inches of the structure. A slow motion device is attached to one of the rollers and is used when bringing the pointed end of the tube into contact with the structure. The clearances of structures within a radius of 4ft to 7ft may be immediately read from the scale, but when distances from 7ft to 10ft are involved the telescopic extension is used.

When the structure has been measured, the pedestal is lifted clear of the rails and the radial arm placed in the travelling position (i.e. in a vertical position with the telescopic portion closed). Two warning lights, one protecting the pedestal, the other the radial arm, are red when the equipment is in use and not in a position for movement. These lights change to green when the equipment has been placed in the correct travelling position and the gauging train may then proceed to the next structure.

A master print is fixed permanently to the plotting board, with lines radiating at intervals of 1 deg. from a pin fixed in relatively the same position as the spindle of the radial arm. A printed negative appropriate to the line to be plotted, i.e. showing the ruling load gauge, is placed over the master print and with a radial scale placed over the pin and rotated similarly to the radial arm, the profiles are plotted.

Hydraulic Vibration Damper

MODERN trends towards the use of coiled spring and torsion bar suspensions in motor vehicle construction have made the use of efficient dampers more important than ever because of the low inherent damping of the suspensions themselves. The illustration below shows a design which has recently been developed and is being put on the market by Spax, Ltd., 61 Fortess Road, London, N.W.5. A pressure chamber 1, attached to the fixing lug on the right, contains the piston 2, which is connected by means of a hollow piston-rod, a disc 8, and dust cover 9, to the left-hand fixing lug. The zinc alloy piston incorporates the restrictor element 3, which is at the basis of the design and consists of a porous disc made of corundum and die cast in position. There are two sets of oil passages in the piston, through which oil can flow between the oil spaces *A* and *B*. One, shown in section near the top edge of the piston, is closed by the disc valve 4 to flow from *A* to *B*, but is open in the reverse direction. This passage connects with the one in the piston-rod which leads to the reservoir space *C*. The other passage (not shown in the diagram) connects *A* with the back of the porous disc. The piston-rod gland consists of the rubber lip seal 5 backed by the steel finger spring 6 and the helical spring 7.

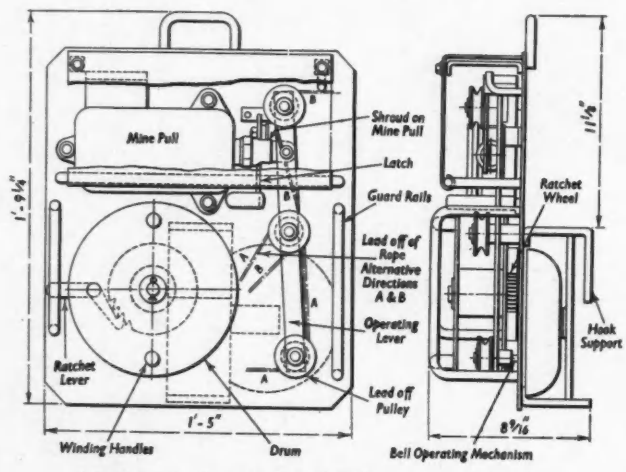
When the damper is expanded, oil is forced through the restrictors, thus providing a damping force which can be of any value within a wide range, according to the porosity selected for the disc. On compression, the oil by-passes the disc 3 by flowing through the top passage. Owing to the restriction offered by the passage itself and the valve 4, a certain amount of reverse flow passes through the disc, thus keeping it free from any sludge which may have formed. Because of the presence of the piston-rod, the volume change in *A* does not equal, for any given stroke, the change in *B*. Reservoir C, which is closed by the rubber disc 10, will accommodate, or supply, the required excess oil.

The section of the damper is amply chosen, as is the surface area of the restrictor. In consequence, little heat is developed and pressures are kept below 800 lb per square inch. The piston-rod is given a fine ground finish, and the cylinder barrel is honed. Assembly of the various body components is by resistance welding. The unit can be mounted at any angle without danger of oil leaking, and the maker claims that tests have shown an extremely long life at constant efficiency. Apart from the telescopic version a number of lever dampers are made to standard sizes and incorporating the same principle.

Pictorial section of telescopic hydraulic damper, showing pressure chamber, piston with porous restrictor and reservoir

Mechanical Signalling and Motor Control Device for Coal-Face Conveyors

PARTICULARS have been received of a mechanically operated signalling and motor control unit for coal-face conveyors which has been developed by The General Electric Company, Ltd. This equipment is fitted with a flameproof pull, latch-out device, mechanically operated bell, and a winch, all mounted on a steel frame. The arrangement of the control and its method of operation can be seen in the drawing above. It can be operated from either side and when its pull wire is pulled the operating lever is rotated clockwise, thereby simultaneously operating both pull and bell mechanisms. Normally the latching device comes into play and locks out the control circuit ; the bell, however, can continue to be worked each time the pull wire is operated. Depression of the latch release bar restores the trip circuit to normal. If the latch is locked out, micro-switch contacts in the pull are immediately reset when the rope is released.



Arrangement of mechanical signalling and control device

The unit is built up on a steel base with a carrying handle and a hook at the rear for attachment, by means of a clamp, to the pit-prop or conveyor structure. A hinged cover encloses and protects the pull and latch mechanism against damage. To protect the winch and operating lever during handling, guard rails are fitted at each side.

The flameproof pull is fitted with two micro-switches and a special gunmetal eye is used to attach it to the operating lever. One of the micro-switches is used for the conveyor motor trip circuit ; the other provides a spare contact, normally open or normally closed as required. A rubber shroud is provided to prevent coal dust getting on the pull spindle during operation. This shroud is secured to the boss on the pull by means of a jubilee clip.

The latch, which is made from steel bar and operates through a slot in the rubber protecting shroud, consists of a pivoted and spring-loaded lever which rides on the barrel of the eye and engages in the gap between the eye and the pull when the switch is operated.

The winch has two stub winding handles and is locked against the movement by a cast iron ratchet and pawl. The winch spindle is in the form of a steel pin bolted through the base. The winch ratchet is provided with thirty-six teeth, giving close adjustment of the rope tension. Approximately 200 yards of ¼in steel wire rope can be accommodated on the drum.

The operating lever, pivoted at the centre, is loosely coupled to the eye of the pull and at the opposite end engages with the bell operating mechanism. The lever also carries three small pulleys for leading off the wire rope in the chosen direction.

An 8in diameter gong is carried on a bracket extension to the rear of the main base-plate with the striker mechanism housed under the dome. Both the gong and the striker mechanism are easily removable for maintenance.

Meeting of British and French Forgemasters

LAST week there was held in London a joint meeting of the Iron and Steel Institute, the National Forgemasters' Association, and the Chambre Syndicale de la Grosse Forge Francaise. The proceedings began on Monday evening with a reception and supper at the headquarters of the Iron and Steel Institute in Grosvenor Gardens. The sessions for the discussion of a series of technical papers started on Tuesday morning, following an official welcome by the Hon. R. G. Lyttelton, president of the Iron and Steel Institute, and Mr. F. Pickworth, chairman of the National Forgemasters' Association. The papers presented on Tuesday were : " Problems in the Manufacture and Ultrasonic Inspection of Heavy Upset Forgings," by Messieurs C. Roques, C. Dubois and P. Bastien, of Les Forges et Ateliers Creusot ; " Reversible Deformation during Thermal Stability Testing of Rotor Forgings," by Mr. H. H. Burton and Mr. J. E. Russell, of English Steel Corporation, Ltd. ; " The Continuous Grain-flow Process and its Recent Applications," by Monsieur P. Verot, of La Societe des Ateliers et Forges de la Loire ; " Forging and Drop Forging Furnaces," by Monsieur Leon Bailly, a Belgian consulting engineer, and " Heating and Soaking Times in Forge Furnaces," by Mr. F. W. Jones and Mr. A. Barker, of Thos. Firth and John Brown, Ltd. On Wednesday there were four papers discussed, as follows : " The Manufacture of a Large Reaction Vessel in Nickel-Chromium-Molybdenum Steel," by Messieurs E. de Kerversean, A. Pierre and P. Lamotte, of Les Forges et Ateliers Creusot ; " Trepan Boring," by Mr. A. H. Bennett, of Walter Somers, Ltd. ; " The New Firming Forging Shop of the Societe des Ateliers et Forges de la Loire," by Monsieur G. Bois, and " A 35,000-ton Die Forging Press for Light Alloys," by Mr. J. G. Frith, of Davy and United Engineering Company, Ltd. At the conclusion of the technical sessions in London the French delegates left for a visit to Sheffield on the invitation of the National Forgemasters' Association.

Social and Industrial Consequences of the Presence of Sulphur in Fuels

No. II—(*Concluded from page 532, October 15th*)

By A. PARKER, C.B.E., D.Sc., F.Inst.F.*

We conclude the opening paper presented at a conference organised by the Institute of Fuel and held in London on October 6th and 7th. The conference was held for a "Special Study of Sulphur Removal and Recovery from Fuels." Here Dr. Parker reviews the general situation.

Atmospheric Pollution by Sulphur

IT has already been stated that the total amount of sulphur in the fuels used annually in Great Britain is about 3·6 million tons, of which less than 200,000 tons is recovered for useful purposes. Some of the remaining 3·4 million tons is retained in the slag in blast-furnaces and in the clinker and ashes from various processes of combustion of coal and coke. Most of the 3·4 million tons, however, is discharged in waste gases to pollute the atmosphere. In these waste gases the sulphur is present mainly as sulphur dioxide and partly as sulphur trioxide; the proportion of sulphur as the trioxide is usually no more than 5 per cent of that as the dioxide.

In the combustion of oil practically the whole of the sulphur is discharged in the waste gases. With coal and coke burnt in domestic heating appliances in general, about 80 per cent of the sulphur is in the chimney gases with 20 per cent in the ash and clinker. When coal and coke are burnt in industrial furnaces where the furnace temperatures are higher than in domestic heating appliances, about 90 per cent of the sulphur appears in the waste gases. One part by weight of sulphur gives two parts of sulphur dioxide, or 2·5 parts of sulphur trioxide, or 3·1 parts of sulphuric acid.

As the sulphur in chimney gases is mainly sulphur dioxide, it is usual to estimate the weight of sulphur dioxide equivalent to the sulphur discharged for a given quantity of fuel burnt. In the accompanying table estimates are given to the

Main Uses of Coal and Oil and Estimates of Amounts of Sulphur Dioxide Discharged into the Air from such uses in Great Britain in 1952

Type and use of fuel	Quantity of fuel, millions of tons per annum	Sulphur dioxide discharged millions of tons per annum
Coal :		
Domestic use	36·9	0·9
Electricity works	35·7	1·0
Railways	13·9	0·4
Industrial, including collieries, and miscellaneous	65·1	1·8
Coke ovens	25·2	0·1
Gasworks	27·9	0·1
Total	204·7	
Total consumption of coke other than at gasworks, but including 11·3 million tons for blast-furnaces	26·1	0·7
Total for coal and coke	—	5·0
Oils, all uses as fuel	15·3	0·3
Totals, coals and oils	220·0	5·3

nearest 0·1 million tons of the sulphur dioxide discharged into the atmosphere from the various uses of coal and its products and oil in Great Britain in 1952.

The figures in the table show that from the use of 220 million tons of fuel (coal and oil) in 1952 there was discharged into the atmosphere an amount of sulphur equivalent to more than 5,000,000 tons of sulphur dioxide or to about 8,000,000 tons of sulphuric acid, if that is the final product. About one-sixth of the sulphur was from domestic grates and stoves, nearly one-fifth from electricity works, two-fifths from railways, collieries and general industry together, and the remainder (about one-fifth) from the combustion of coke, the use of oil, and the operations at coke ovens and gasworks.

The ultimate effect of such discharges of waste gases on the incidence of pollution of the air at or near ground level by sulphur dioxide, sulphur trioxide, and sulphuric acid mist is dependent on a number of factors, including local topography, height of chimney, velocity, temperature and amount of the gases discharged from each chimney in the area, various meteorological conditions, including the direction and velocity of wind, the rate of conversion of sulphur dioxide to sulphur trioxide and sulphuric acid, and the rate of absorption of the sulphur oxides by rain, buildings and materials, vegetable growths, &c. Much more fuel is consumed in the winter than in the summer, and very much larger quantities are consumed per square mile in thickly populated industrial areas than in rural districts.

With all these many and changing factors it is not yet possible to predict with the desired accuracy what effect any particular discharge will have on local and more distant pollution of the air by sulphur oxides, though progress is being made in studies of the effects of the various factors.

The importance of obtaining systematic records of the incidence of the major forms of air pollution has long been recognised in Great Britain. In 1912 there was set up an Advisory Committee on Atmospheric Pollution, which a few years later became a Committee of the Meteorological Office. One of the major activities was to institute a survey of the incidence of pollution in different parts of the country. In 1927 the work of the Committee was transferred to the D.S.I.R., and in 1945 the Atmospheric Pollution Research Committee was reconstituted as a Committee of the Fuel Research Board to facilitate closer co-operation with the work of the Fuel Research Station in improving the methods of preparing and using fuels and of reducing the amounts of the pollutants discharged. From the beginning the scheme has received the active and increasing support of local health authorities and other co-operating bodies. The number of measuring instruments in regular use is now about 1400, which is four times as many as seven or eight years ago, and the increase continues. About one-half of these instruments are for the measurement of sulphur dioxide.

In the air of towns, at or near ground level, the concentration of sulphur dioxide in winter is generally in the range of 2 to 35 parts per 100 million by volume, with much lower concentrations in the summer. When there is a temperature inversion in the atmosphere, as at times of fog, the concentration of sulphur dioxide near ground level may rise well above the average. For example, during the severe fog in London in December, 1952, with greatly reduced natural ventilation over a continuous period of several days, the concentration of sulphur dioxide in some parts of London rose to about ten times the normal for that time of the year.

Damage by Sulphur in the Atmosphere.—There is ample evidence from many investigations to show that the oxides of sulphur discharged into the atmosphere from the combustion of fuels have a serious detrimental effect in accelerating the decay and destruction of stone and other building materials, the corrosion of metals, and the rotting of fabrics of many kinds. It has also been proved that they cause injury to plant life, even to the extent of killing plants, when the concentration of the oxides of sulphur is unusually high.

From attempts to estimate the cost of the material damage caused by atmospheric pollution it has been suggested that at present prices the annual cost in this country is in the region of £100 million to £150 million. But this pollution includes not only oxides of sulphur but also smoke, grit and other substances. It seems probable that the detrimental effect of the sulphur is increased by the presence of the other pollutants. For example, it has been shown that corrosion of metals proceeds from nuclei provided by dispersed solid particles in the atmosphere. An attempt some years ago to allocate the cost of the damage by the various pollutants suggested that about two-fifths of the cost could be attributed to the oxides of sulphur. Any estimate of this kind cannot be more than a guess, because it has not been possible to undertake investigations in which the various factors could properly be separated.

There is no doubt that air pollution also has serious detrimental effects on health. The exceptional "smog" which covered London from December 5 to 9, 1952, was accompanied by an immediate and sudden rise in both illness and mortality. The number of deaths above those normally expected in the first three weeks of December indicated that some 4000 people died as a result of the "smog"; there were great increases in the number of deaths from bronchitis and pneumonia. It is not possible to assess the proportionate effect on health of the various pollutants or of the low atmospheric temperature that is usual at times of fog. It seems probable, however, that the oxides of sulphur constituted one important factor in the damage to health.

Removal of Oxides of Sulphur from Flue Gases.—There have been many investigations with the object of devising satisfactory methods of removal of oxides of sulphur at reasonable cost from waste flue gases from the combustion of fuels, so as to reduce air pollution by sulphur. In these investigations Great Britain has played a leading part. The only processes that have been operated for long periods on a large scale are those that have been used at the electricity generating stations at Battersea, Bankside and Fulham, in London. Removal of sulphur from such waste gases has not been practised anywhere else in the world.

By the method in use at Battersea the gases are washed with Thames River water to which small quantities of chalk are added. In this process the natural alkalinity of the river water and the added chalk, followed by oxidation, converts the sulphur dioxide into calcium sulphate, which remains as a dilute solution in the water. With coal containing 1·5 per cent of sulphur as the fuel it is necessary to pass through the scrubber about 35 tons of water from the river for each ton of coal burnt in the boilers; and there is a similar volume of liquid effluent to be discharged to the river. At present prices for new plant the overall cost of the process (capital, operation and maintenance) is equivalent to an addition of from 8s. to 10s. to the cost of each ton of coal consumed. With improvements based on experience at Battersea and on the results of further investigations on pilot plant scale, the method (now known as the B.E.A.-Battersea process) is also used at the oil-fired power station at Bankside.

According to the process (Howden-I.C.I.) used at the Fulham power station before World War II, but not now in operation, the flue gases are washed with a suspension of chalk in water, which is circulated continuously through the gas scrubbers. Chalk is added continuously and the sulphur extracted from the gas is removed as a sludge of calcium sulphate. There is no liquid effluent for disposal. At Fulham the sludge obtained was of little or no value and was disposed of mostly by dumping at sea. At present prices the overall cost of this process, with coal containing about 1·5 per cent of sulphur, would be in the region of 12s. to 14s. per ton of coal.

Both the B.E.A.-Battersea and the Howden-I.C.I. processes are capable of removing more than 90 per cent of the sulphur in the flue gases, but they lower the temperature of the gases discharged from the chimney by about 80 deg. Cent., thereby increasing the tendency of the gases to descend to near ground level under certain meteorological conditions. Neither process removes the sulphur in valuable form.

A number of other possible methods of removing sulphur from flue gases have been studied and several of them have been submitted to experimental investigation. Of these various methods, the one showing greatest promise of success at reasonable cost is that in which the gases are washed with a solution containing ammonia. This method has been investigated in some detail in the laboratory and with small pilot plants. With relatively pure ammonia the sulphur is recovered as ammonium sulphate. With ammonia in the form of concentrated gas liquor most of the sulphur is recovered as ammonium sulphate and some as fairly pure sulphur. Consideration is now being given to the question of further development of the process with a much larger pilot plant at a power station. Provisional estimates of cost indicate that the overall cost of the process, after allowing for the value of the products, would be in the region of 2s. per ton of coal with coal containing about 1·5 per cent of sulphur. With coal containing 2·5 per cent or more of sulphur, the probability is that the value of the products would cover the costs. In this process also the temperature of the gases to be discharged from the chimney is reduced; it is important, therefore, that it should remove at least 85 per cent of the oxides of sulphur.

* Director of Fuel Research, Department of Scientific and Industrial Research.

High Production Magnesium Mill in Illinois

(*By Our American Editor*)

With the new magnesium mill of the Dow Chemical Company at Madison, Illinois, going into full production recently, some of the most advanced magnesium alloy casting, rolling and extrusion plant is now facilitating the manufacture in the United States of wide sheet and plate, coiled sheet and strip, and large, complex extruded sections. The plant employs continuously cast ingots weighing up to 2000 *lb and can produce coils up to* 84*in wide. The rolling mill has a nominal rated capacity of* 16,000,000 *lb per annum, and the extrusion mill one of* 12,000,000 *lb per annum.*

UNTIL recently the production of rolled magnesium alloy products in the United States was based on small-scale mill operations involving ingots of only 100 lb to 200 lb weight and producing sheets of 4ft maximum width. The increasing market for wrought magnesium alloy products has now led to the first true high-production mill being established at Madison, Illinois, by the Dow Chemical Company, the leading American producer of magnesium. The original rolling and extrusion facilities of the company were situated at Midland, Michigan, and, during the last war, were devoted entirely to military use.

Following the war, considerable quantities of magnesium sheet from the Midland works went into such commercial fields as materials handling equipment, tread plate, pattern plate and photo-engraving plate. At this time an increase in sheet rolling capacity was considered by the company. Certain challenging problems presented themselves at this time—problems such as the need for basically larger facilities to process 2000 lb rolling ingots instead of the conventional 100 lb ingots, coil rolling, and the need for a better plant location with respect to raw materials and markets. In July, 1946, at the plant of the American Rolling Mill Company, at Butler, Pennsylvania (the original tandem hot strip mill in the United States), the feasibility of rolling magnesium on a modern mill was demonstrated for the first time. In the course of this test, 800 lb magnesium ingots were broken down on the reversing hot mill, passed directly to the four-stand tandem mill, and were coiled at 0·064in thickness at a speed of 1200ft per minute —the entire operation being completed in four minutes. By January, 1949, it became evident that more magnesium rolling capacity would

Loma " flying " saw cutting off continuously cast magnesium ingot

be needed for the enlarged American defence programme. In February, preliminary surveys of markets and available plant sites were undertaken by the firm. By March, 1950, the Madison site had been studied and a proposal developed for an integrated rolling mill and extrusion plant to replace the facilities at Midland. In January, 1951, the Dow Chemical Company received deed to the Madison works and in March rehabilitation was started.

In the meantime, the shortages of thin magnesium sheet had become so critical that the U.S. Air Force procured a 66in non-reversing, four-high, single-stand sheet finishing mill in June, 1951, which was then installed at Madison. First sheet was produced on this mill in March, 1952, less than one year after the initial contract was signed for the mill. In October, 1953, less than three years after the deed to the works was received, the 84in reversing, four-high, single-stand hot mill was placed in operation. The 84in non-reversing, four-high, single-stand cold finishing mill was placed in operation in February, 1954, followed by the completion of a 36in cold strip mill and auxiliary units, such as ovens, shears and pickle lines. During the period of installation of the rolling mills, facilities for the continuous casting of 2000 lb rolling ingots, the usual extrusions billets, and a line for the casting of remelt alloy ingot were installed at Madison.

In the meantime, the company's extrusion equipment had been modernised and moved to Madison from the Midland works. In November, 1952, the company signed a contract with the U.S. Air Force for the installation at Madison of a 13,200-ton extrusion press made by Hydraulik in Germany. The complete facilities at Madison represent an important step from what might be termed " pilot plant " production to mass production of magnesium mill products. The significance of this development lies in the ability of the mill to produce a better product at a low price, making available to industry wider and longer sheet and plate, and extrusions in a variety of shapes and sizes held to better tolerances than had previously been available.

Casting Operations

All operations begin in the melting and casting shop, where more than thirty melting furnaces, built by the Eclipse Fuel Engineering Company, prepare the metal for casting into rolling ingots, extrusion billets or remelt ingots. A representative casting operation involves a battery of seven furnaces or pots. Magnesium pig from the Freeport reduction works of the company is melted in two pots, and is then transferred to two alloying pots. From there it goes to a settling pot, to a holding pot, and finally to the casting pot. The transfer of metal from pot to pot is accomplished by air-drawn pumps. The metal is held at constant level in all but the settling pot, which is emptied before receiving fresh metal from the alloying pots.

The continuous casting process employed is fundamentally similar to that used in aluminium rolling mills, but a number of interesting refinements have been incorporated. As molten metal is fed into the shallow " bottomless " mould, it is quickly cooled and solidified by jets of water. The solidified metal slowly descends at a metered rate into the casting pit, thus forming the base or mould bottom as more metal is poured and chilled. In this way, a " growing " ingot is continuously produced. To begin the operation, however, it is necessary to lower a 30ft cast ingot through the shallow mould into the casting pit. This forms the casting base for the new metal. Once started, the process could, theoretically, continue indefinitely. When the mould reaches a predetermined length a rotary " flying " saw made by the Loma Machine Manufacturing Company and situated deep in the casting pit automatically cuts off a rolling ingot of the desired length. Since the movement of the growing ingot cannot be stopped, the saw is rigged to move down with the ingot. After the rolling ingot is cut from the continuous ingot, a 2in thick slice is cut off for testing purposes. Grain size and cleanliness of the metal are checked and the surface is examined for cracks or other defects. Of the 4,000,000 lb of metal cast monthly at Madison, about 1,000,000 lb goes to foundry uses, 1,500,000 lb for extrusion ingot, and the rest for rolling billets.

The rolling billets, which are 76in long, 41in wide and 11in thick, are hoisted to floor level and conveyed to the scalping department, where an Ingersoll face miller removes ½in of metal from each face of the billet. All handling

Hydraulic manipulation of rolling ingot at Ingersoll scalping machine

operations are hydraulically powered on this machine, which can remove ½in of metal in a single pass, and at rates of up to 15ft per minute. A powered roller conveyor then carries the billet to an edge miller which removes ½in of metal from each edge at rates of up to 10ft per minute. Carbide-tipped tools are used in both of these machines. The milling chips, carried by power conveyors into tote boxes, are sent back to the melting department.

Rolling Operations

The freshly scalped billet is now ready to be transformed into sheet or plate. A mill bogie transfers it to the gas-fired, two-stage preheating furnace, where it is brought to rolling temperature —between 800 deg. and 900 deg. Fah., depending upon the alloy. The billet is heated to within a few degrees of rolling temperature in the first zone and then transferred to the holding zone to await its removal to the break-down mill. Like all the new rolling equipment at the Madison works, this 84in reversing, four-high, single-stand hot mill was designed and built by the United Engineering and Foundry Company expressly for rolling magnesium. A dual-purpose mill, it performs both breaking down and semi-finishing work.

This versatility is obtained by the use of a " convertible " work table at the entry side of the mill. When break-down work is being performed, the full table is brought into play. The 10in thick billet is reduced in thickness to 0·200in in ten to twenty passes without reheating, and the sheet is coiled on the final pass. The maximum break-down speed is 600ft per minute. When the mill is to be used for semi-finishing sheet lighter than 0·200in, a segment of the entry table is tilted back out of the way by a hydraulic mechanism, and a coil box for lighter

rolling is brought into action. The maximum speed for this operation is 1100ft per minute, and the minimum thickness of semi-finished sheet is 0·051in. In line with its dual-purpose function, the 84in hot mill has been equipped with double screwdown drives, providing the necessary high speeds for roughing work and slower and more accurate speeds for finishing.

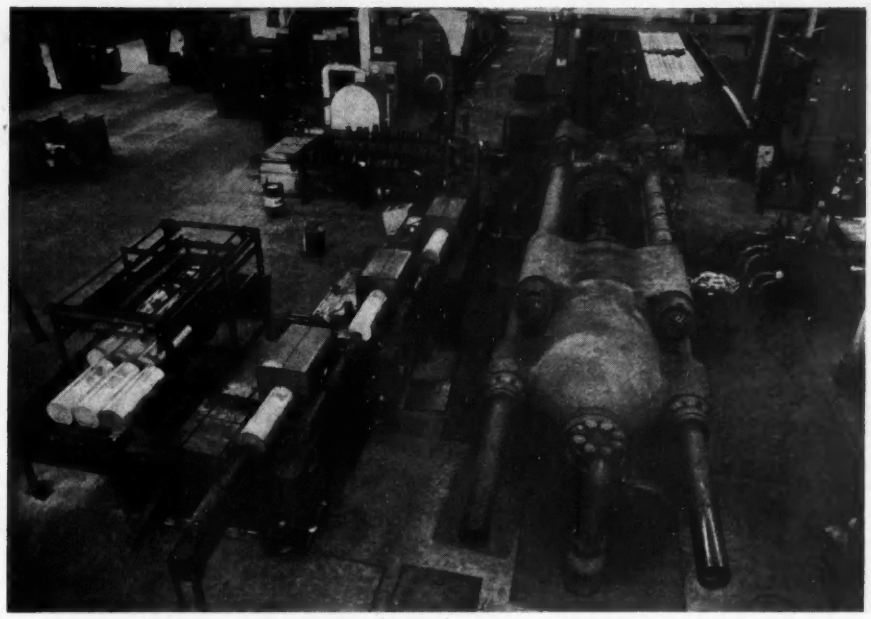
In order to produce sheet measuring as much as 72in in width, it is necessary to increase the width of the billet by cross rolling. A portion of the entry table is fitted with split rolls which can be run in opposite directions, thus enabling the operator to turn the billet in any direction. Early in the break-down operation, he runs the billet through sideways a few times, increasing its width enough to make the required wide sheet. The mill is also equipped with 42in diameter edge rolls at the entry side, which are applied to prevent edge cracking in the rolled product. The main drive of the mill has a design rating of 6000 h.p. and the edging roll drive one of 1500 h.p. The mill is equipped with a 400ft long powered run-out table, which permits the rolling of long sections of plate as well as coiled sheet.

Additional rolling equipment at Madison works includes an 84in four-high strip, sheet, plate and coil mill ; a 68in four-high strip and coil mill ; a 66in four-high sheet mill ; a 36in four-high strip mill, and an 18in four-high strip mill. The 84in cold mill is equipped to produce plate and tread plate lengths of up to 24ft.

Gas-fired heat-treating furnaces have been installed to service each of these mills, and virtually all handling operations are carried out by powered roller conveyors. Manual operations are held to an absolute minimum throughout the plant. The new installation includes a 175ft long pickling line, in which the finished cut-to-length sheet is degreased, rinsed, pickled, rinsed in cold water, rinsed in hot water, and finally dried.

Extrusion Operations

The extrusion department at the Madison works is now the largest magnesium extruding facility in the United States. At present, it consists of five presses with auxiliary equipment. Three of the presses—a 1700-ton "Baldwin Southwark," a 3000-ton "Hydropress," and a 5500-ton "Hydropress" unit—were moved to Madison from the company's Michigan plants. The two new presses—a 1700-ton and a 3000-ton "Hydropress" unit—both have self-contained hydraulic equipment.

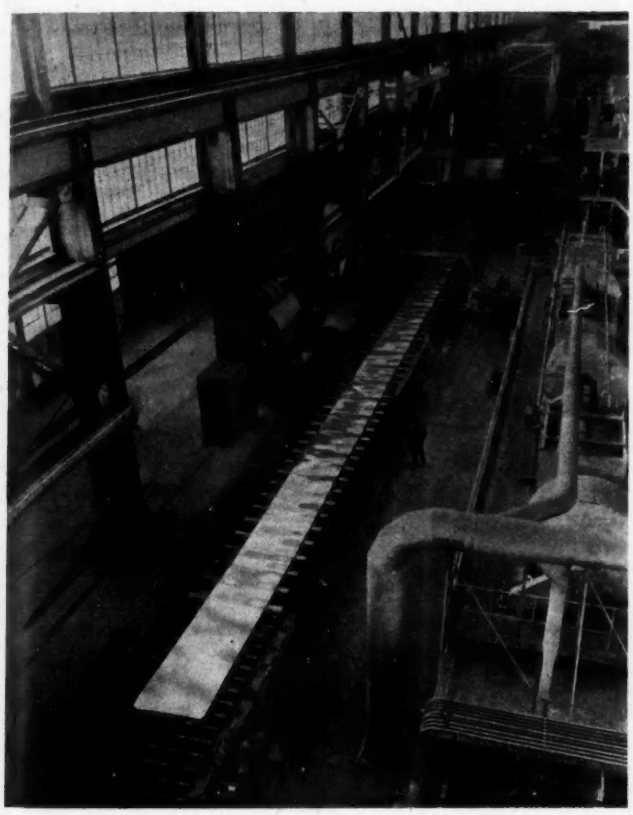


"Hydropress" 5500-ton extrusion press with three stage billet induction heating unit

The nominal rated capacity of the extrusion department is 12,000,000 lb per year. The maximum extrusion size for rounds, squares, hexagonals and tubing is limited to a 10in circumscribing circle. Certain standard shapes, such as channels and angles, may exceed this limitation, however. The maximum length of extruded sections is 85ft, depending upon shape, weight per foot, and equipment used. Aged extrusions can be produced up to 45ft long, and the normal maximum length of chrome-pickled extrusions is 45ft, too. The following table lists the alloys which are currently extruded at Madison :—

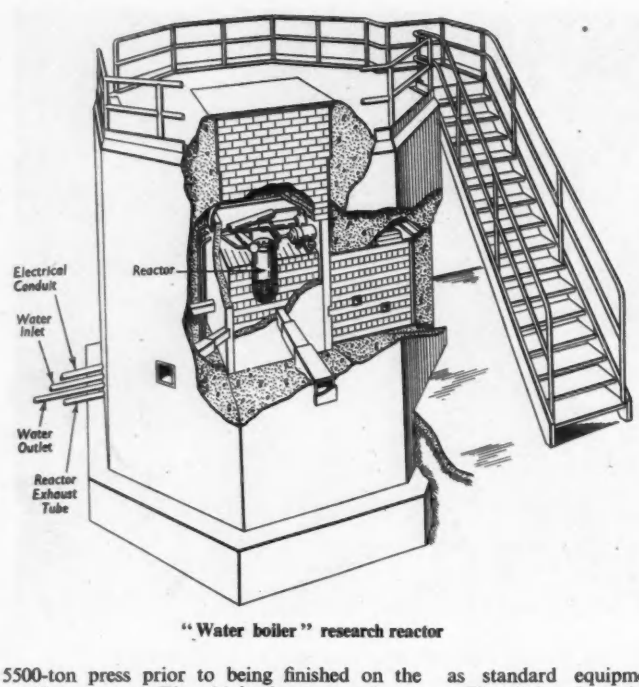
Alloy	Composition, per cent				
	Al	Zn	Mn	Zr	Mg
M	—	—	1·2	—	Remainder
FS	3·0	1·0	—	—	Remainder
FS1	3·0	1·0	—	—	Remainder
J1	6·5	1·0	—	—	Remainder
O1	8·5	0·5	—	—	Remainder
ZK60A	—	5·7	—	0·55	Remainder

All billets, with the exception of the ZK60A alloy, are scalped and pre-extruded on the

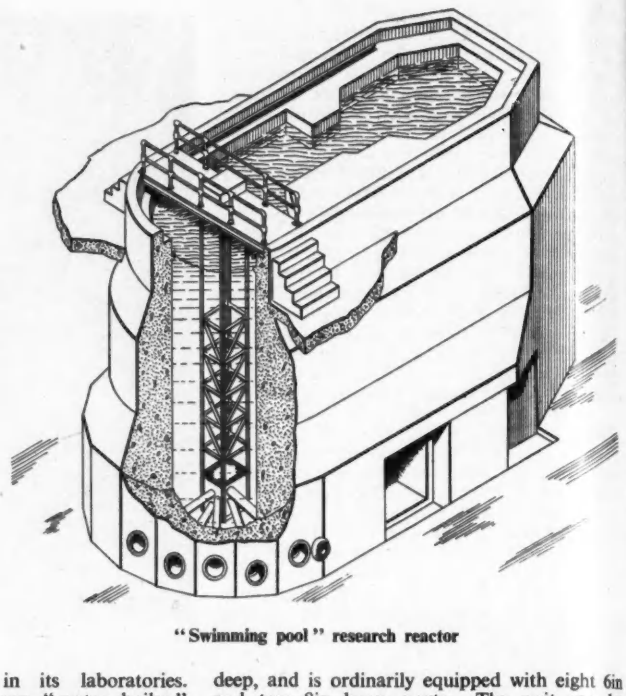


84in reversing four-high, single-stand hot mill with run-out table

66in non-reversing four-high, single-stand cold sheet finishing mill



"Water boiler" research reactor



"Swimming pool" research reactor

5500-ton press prior to being finished on the smaller presses. The chief advantages of pre-extrusion are the superior mechanical properties obtained and the faster production rate. The big press, which handles billets up to 16in in diameter and 40in in length, is used to produce extruded sections as well as pre-extruded billets for the smaller presses. One interesting product turned out on this press is a 6in diameter tubing used in oil-well drilling. The tube is sunk into the ground and a dynamite charge is exploded inside the tube to loosen the earth for further investigation.

Billet heating for all five presses is performed by induction billet heaters made by the Magnethermic Corporation. The 5500-ton press uses a special three-stage heater in which the billets are brought to extrusion temperature by three successive induction coils. With this arrangement, three billets are passing through the heating stages while extrusion is in progress. Other equipment in the extrusion department includes die heaters, cut-off saws, heat-treating furnaces, extrusion stretchers, and pickling tanks.

It is of interest to note that the Dow Chemical Company is expecting to add titanium alloys to its products some time in the future. The firm is currently building an 1800-ton titanium production plant based on a modified Kroll process and may ultimately produce titanium alloy castings, extrusions, forgings and sheet.

Two Nuclear Research and Development Piles

THE Atomic Energy Division of the Babcock and Wilcox Company, of New York, recently placed on the market two atomic research reactors of relatively low cost, which are intended for training personnel for the nuclear power industry, as well as for conducting basic nuclear research and development. The designs involved are modified versions of the declassified "water boiler" and "swimming pool" reactors developed at Los Alamos, Oak Ridge and other installations of the U.S. Atomic Energy Commission, The piles are both useful in neutron experiments, radiation chemistry, biological research, isotope production and materials development, in addition to their value in engineering education. The "swimming pool" reactor will probably cost more than the "water boiler" reactor, but will also offer certain advantages, such as space for bulk shielding and similar experiments, which the "water boiler" reactor does not provide. On the other hand, the "water boiler" has been designed to obtain the highest possible neutron flux per dollar invested. The main reason for the development of these reactors is the company's belief that every large university and college in the United States will eventually have a research reactor as standard equipment in its laboratories.

The Babcock and Wilcox "water boiler" reactor is a semi-homogeneous unit comprising a solution of enriched uranium sulphate in water as fuel and moderator, and a separate cooling system. Its rated power is from 200kW to 400kW, but it can be operated at any power below this level. The uranium sulphate solution is contained in the lower half of a cylindrical vessel with a spherical bottom. The vessel is 10in in inside diameter by 3ft high. The shell is $\frac{1}{16}$in thick and is made of A.I.S.I. type 347 columbium stabilised 18-8 stainless steel. Boron control and safety rods extend down into the core from above. The core is situated in the centre of a 4ft cube of graphite reflector, which in turn is surrounded by a 4in carbon steel thermal shield. A 5ft extension of the graphite reflector on one side serves as a thermal column. The pressure above the fuel solution is maintained at −6in of water as a safety measure in order that any leakage will be into the reactor gas system rather than out into the reactor room. Hydrogen and oxygen gases created by fission-induced dissociation of the water in the fuel solution are diluted with helium to keep the concentration well below the danger point and are then recombined in a catalyst bed and returned through a closed loop to the core. The cooling system comprises U-shaped cooling tubes of type 347 stainless steel placed so that they dip down into all parts of the fuel solution and maintain the fuel temperature at a constant level below the boiling point. The coolant is ordinary water.

The reactor and its components are contained in an octagonal, high-density concrete shield. Aluminium exposure ports extend to the core or reflector from all shield faces, and two ports are situated in the thermal column. The air space within the shield is maintained at a slightly negative pressure as a secondary safety measure. The overall design of the water boiler reactor is similar to that of the Los Alamos water boiler of the A.E.C. The introduction of more cooling capacity, however, permits an operation at higher power and the production of a higher thermal flux than can be obtained with an ordinary water boiler. The total flux density of the unit is in the order of 10^{13} n/cm²/sec. The unit has been designed for high specific power and high thermal flux. The total power and therefore the critical mass is nevertheless relatively low compared with other designs of reactors.

The outstanding characteristic of the Babcock and Wilcox "swimming pool" reactor is its high degree of flexibility. This reactor is a modified version of the Oak Ridge bulk shielding facility reactor. Its maximum power is about 1000kW. The core is heterogeneous, with a minimum critical mass of 2·75 kg. The pool is approximately 10ft wide by 20ft long by 25ft deep, and is ordinarily equipped with eight 6in and two 8in beam ports. The unit can be operated with a variety of core patterns with or without a partial or full reflector of graphite or beryllium oxide. Control is accomplished by rods integrated with the core suspension and actuated by a simplified drive mechanism.

In addition to its standard beam ports, the "swimming pool" reactor usually incorporates three pneumatic tubes for fast "rabbit" experiments. Provision has been made for the inclusion of special ports and experimental tubes in a number of different arrangements. At full power the core is cooled by the recirculating pool water through a heat exchanger at the rate of 1000 U.S. gallons per minute. The pool water is continuously deionised to prevent the build-up of radioactivity and, in the event of a power failure, the inlet header will automatically disengage to permit natural convection cooling. The shield is constructed of high-density concrete.

American Wrought Aluminium Alloy Designations

A NEW system of alloy designations for wrought aluminium and aluminium alloys has been developed by the Aluminum Association of New York City and became effective on October 1, 1954. The temper designations adopted in America in 1947 are being continued without change and, as in the past, will follow the alloy designations, being separated from them by a dash. The new system consists of four-digit numbers. The first digit of each designation indicates the general group to which a given alloy belongs. The last two digits identify the alloy or indicate the aluminium purity. The second digit indicates any modifications of the original alloy or impurity limits.

To aid in the transition from designations previously in use to the new system, many of the old numbers are being retained as the last two digits of the new numbers. The numbering system includes nine series of four-digit numbers. The "1xxx" series, designating minimum aluminium purities of 99·00 per cent and higher, differs basically from the other series. The last two digits indicate the minimum aluminium percentage. These digits are the same as the two digits to the right of the decimal point in the minimum aluminium percentage when it is expressed to the nearest 0·01 per cent. The second digit designates any modifications in the impurity limits. If the second digit is zero, it indicates that there is no special control on individual impurities.

The "2xxx" to "8xxx" series designate groups of alloys with major alloying elements and the last two digits have no special significance other than to identify the different alloys in the group.

Industrial and Labour Notes

National Production Advisory Council

The quarterly meeting of the National Production Advisory Council was held in London last Friday under the chairmanship of the Chancellor of the Exchequer, Mr. R. A. Butler. The Chancellor presented to the meeting an appraisal of the country's economic situation, in the course of which he emphasised that one important way of raising the level of world trade was to press on with overseas investment, which would help to generate higher production and incomes abroad. This country's economic policy, the Chancellor said, was designed to enable it to continue to invest substantially overseas. Between 1946 and 1953, United Kingdom long-term overseas investment had averaged about 1½ per cent of the national income.

The Chancellor went on to say that his last two budgets had been designed to encourage a higher rate of industrial investment. It was still early days to see how industry had responded to the investment allowances, but the evidence already forthcoming was somewhat encouraging. There was more factory building work going on this year than last, and there had been an increase in authorisations for factories yet to be built. Deliveries of engineering products to the home market were at a higher rate in the first half of 1954 than in the preceding years and there was a marked rise in the flow of orders. Generally, the Chancellor continued, the picture of industrial production was a good one, the increase of 6 to 7 per cent over a year earlier having been maintained in recent months. The engineering, vehicles, paper and printing, and chemicals industries had made the biggest contribution to the output rise. In engineering, the gain in the first half of this year, compared with a year earlier, was 6 per cent, and within the group it was encouraging to note that plant and machinery production was picking up steadily towards its best figures. This increase in industrial production, the Chancellor observed, had meant a large increase in the home demand for coal. Although coal output had been increasing, it had not been increasing quickly enough to match the demand. Deep-mined coal output was now up by about 2,000,000 tons on last year, but difficulties in securing sites had led to a decline in opencast production of 700,000 tons. If we looked further ahead, the Chancellor said, and assumed that industrial production would go on increasing, present trends of coal output suggested that coal imports would increase, which would mean a most unwelcome addition to the import bill. He suggested, therefore, that the outlook should be improved by "taking two steps forward on coal." The first was to get more output from our own mines and to have a drive to reverse the drift of men from the mines to other industries. The second step was to extend fuel economy and efficiency throughout industry.

Finally, the Chancellor said, the industrial labour force as a whole had reached record peace-time levels and unemployment had been very low. The rise in employment had helped to push up output, though higher productivity had made the most important contribution to the increase and had helped us to carry an increased wages bill without prices rising. It could at least be said, therefore, that things were moving in the right direction, although we could not be satisfied with the pace. That, the Chancellor remarked, was why he hoped to see signs of a real upsurge in investment and a continuing rise in productivity.

Industrial Fuel Efficiency

At the meeting of the National Production Advisory Council, referred to in a preceding note, a statement was presented by the Minister of Fuel and Power that, up to date, loans had been approved for eighty-one fuel-saving schemes which had been submitted. These loans amounted to £559,000, and further schemes amounting to £220,000 were under consideration.

The statement added that a recent survey of steam and power usage in industry had shown that considerable amounts of power were privately generated by back-pressure turbine installations. It was explained that industrialists who wished to install back-pressure generating schemes were eligible to apply for loans up to £30,000 per installation.

Motor Company's Expansion Programme

At the beginning of the week Sir Patrick Hennessy, deputy chairman and managing director of Ford Motor Company, Ltd., announced some details of a £65,000,000 expansion programme which the company proposes to carry out over the next five years. He said that production requirements necessitated an increase of factory floor space of about 4,000,000 square feet in all, in addition to the modernisation and re-equipment of existing manufacturing facilities. The programme includes the construction of a new foundry and press shop. Satellite factories are to be established around the company's main works at Dagenham, including machine shops at Basildon New Town and a spare parts depot at Aveley. The company also proposes to take up part of the Woolwich Arsenal site, the purchase of which by the London County Council is reported on another page of this issue.

Foundry Amenities

The Council of Ironfoundry Associations has published an illustrated booklet entitled "Years of Endeavour," which describes the many efforts made by the ironfounding industry in recent years to improve working conditions. In presenting this booklet, the Council aptly recalls that, a long time before new statutory regulations affecting safety in iron and steel foundries came into force at the beginning of this year, there was a strong voluntary movement among founders directed to the betterment of working conditions.

That work was, of course, encouraged by the report of the Garrett committee, which was produced soon after the war ended. The three principal matters to which the committee urged that attention should be given were: provision of better amenities and more comfortable and healthy working conditions; improvement of the appearance of ironfoundries through better cleanliness and orderliness, and more light and colour; and improvement of the atmospheric conditions by prevention or removal of dust, smoke and fumes. The measure of success achieved to date in these and other directions in foundries in this country is admirably emphasised in the booklet.

Copies of the booklet may be obtained, free of charge, from the Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1.

Iron and Steel

Figures issued by the Iron and Steel Board show that British steel production in September averaged 372,300 tons a week and was therefore at an annual rate of 19,358,000 tons, compared with an annual rate of 18,019,000 tons in September last year. The annual rate of production over the third quarter of this year, which included the annual holiday season, was 16,865,000 tons, compared with 16,019,000 tons in the corresponding quarter of 1953. Pig iron output in September was at an annual rate of 11,591,000 tons, which was a little below the August figure. The Iron and Steel Board says that the decline was accounted for by certain blast-furnaces being out of production for relining. Pig iron output over the whole of the third quarter was at an annual rate of 11,476,000 tons, compared with a rate of 10,787,000 tons last year.

Steel output in the third quarter of this year suffered from some interruption apart from that caused by holidays. Production in the first three quarters of the year, however, was at a record annual rate of 18,320,000 tons, compared with 17,390,000 tons in the corresponding period of 1953, and the Board states that there is a good prospect that the total for the year will reach 18,500,000 tons. It has been estimated that at the end of September pig iron stocks amounted to 652,000 tons and stocks of scrap to 712,000 tons, compared with 568,000 tons and 629,000 tons respectively a year earlier.

The Board's statement goes on to say that demands for finished steel continue to rise, and that pressure upon supplies has been felt in sheets, tinplate, certain sizes of girders and wire rods. Total imports of sheet this year are expected to be round about 200,000 tons, a substantial quantity of which is coming from the U.S.A. and the remainder from the Continent. Imports of semi-finished steel, principally billets, which have hitherto formed a large proportion of total imports, have now declined as production has increased in this country. Although the increase in the total supplies of steel this year has gone for the most part to satisfy home demands, exports have shown a moderate expansion. In the first six months of the year steel exports totalled 1,015,000 tons, or 57,000 tons more than in the first half of 1953.

Strikes at the Docks

As these notes go to press, work in the London docks is at a standstill through strikes which have now been in progress since the beginning of the month. The two unions principally involved are the National Amalgamated Stevedores and Dockers and the Transport and General Workers Union. The former has been operating a ban on overtime for several months on the plea that overtime working should be voluntary. The port employers therefore refused to negotiate on this or any other matter—except a dispute over meat sorting—until the ban is lifted. The stevedores and dockers union then called a strike in which, subsequently, other dock workers belonging to the Transport and General Workers Union have joined, against the advice of their union officials. Last week-end the Watermen, Lightermen, Tugmen and Bargemen's Union joined the strike "officially."

This stoppage, which has now spread to some other ports, notably Liverpool and Birkenhead, is naturally one that has serious repercussions on the export trade of the country. The Minister of Labour has set up a court of inquiry, under the chairmanship of Sir Raymond Evershed, Q.C., to examine the dispute; it held its first meeting on Wednesday last.

Meanwhile, a strike of ship repair workers in the Port of London continues. This also began early in October, because five members of the Electrical Trades Union were declared redundant. More than a dozen unions concerned with ship repair, and affiliated to the Confederation of Shipbuilding and Engineering Unions, are involved in this dispute.

Industry in the New Towns

The reports of the Development Corporations of the new towns being built in this country under the New Towns Act, 1946, show that in several of them good progress is being made in the establishment of industrial concerns. The reports, which cover the year ended March 31st, were published last week by H.M. Stationery Office (price 17s. 6d.), as a Blue Book.

It is significant that a large proportion of the factories under construction or already occupied in the new towns has been taken by engineering firms. At Crawley, for example, out of thirty-eight factories completed, or nearing completion, twenty have been taken by light engineering and allied concerns. At Harlow, also, of the thirty-two factories occupied at the end of March, twenty-five are devoted to light engineering. Nine factories have been completed at Basildon, the report stating that the industry being attracted is "mostly classified as light engineering." At Hemel Hempstead the area of factories completed by the end of March totalled 385,000 square feet, while another 316,200 square feet was under construction and plans were in hand for a further 115,000 square feet of factory space. At Stevenage, thirteen factories had been let by the end of March, ten of them to engineering and allied concerns.

Notes and Memoranda

Air and Water

PRESIDENT-ELECT OF THE ROYAL AERONAUTICAL SOCIETY.—It is announced that Mr. N. E. Rowe has been selected president-elect of the Royal Aeronautical Society and will take office as President at the annual general meeting to be held on May 5, 1955. Mr. Rowe served an apprenticeship in marine engineering at Devonport Dockyard and, after service in the first world war, he attended Imperial College, holding a Royal Scholarship and Whitworth Exhibition. He gained his A.C.G.I. and B.Sc. and in 1924, after post-graduate work in hydro-electric engineering, a Diploma of the Imperial College. From 1924 to 1946 he was employed by the Air Ministry and the Ministry of Aircraft Production, becoming Director of Technical Development in 1941 and Director-General of Technical Development in 1945. In 1944 he was awarded C.B.E. for work in the Ministry of Aircraft Production. From 1946 to the end of 1951, when he joined Blackburn and General Aircraft, Ltd., Brough, as technical director, Mr. Rowe was the Controller of Research and Special Developments, British European Airways.

Miscellanea

APPLICATIONS OF SECOND LAW ANALYSIS.—The author of this article, which appeared in our issue of October 8th, points out that an error needs correction under the heading "Availability Function." The third last sentence should read "For the latter case the available energy may be shown to be $(E+p_0v-T_0s)$ for a fluid having a given internal energy E volume v, &c. . . ."

FOUNDRY FURNACE FUELS.—The Association of Bronze and Brass Founders is to hold a meeting at the Clarendon Restaurant, Hammersmith, London, W.6, on Wednesday next, October 27th, at 2 p.m., to discuss alternative furnace fuels for non-ferrous foundries. Introductory talks will be given by Mr. L. Clegg and Mr. R. L. Robinson, of the National Industrial Fuel Efficiency Service.

MR. H. J. DEACON.—We have learned with regret of the death of Mr. Henry James Deacon, M.I.Mech.E., which occurred on September 29th at the age of fifty-six. Mr. Deacon had been on the staff of Standard Telephones and Cables, Ltd., since 1923. He received his practical training in the Royal Ordnance Factories at Woolwich, and immediately after the first world war spent some time at the Fraser and Chalmers Engineering Works at Erith, prior to joining Standard Telephones and Cables, Ltd. In the second world war he was largely responsible for the dispersal of his company's activities and subsequently for reconsolidating them in the immediate post-war years.

400W COLOUR-CORRECTED MERCURY DISCHARGE LAMPS.—Three firms—The British Thomson-Houston Company, Ltd., The General Electric Company, Ltd., and Philips Electrical, Ltd.—have announced, independently, the introduction of a new 400W colour-corrected mercury discharge lamp. Colour correction is achieved by a fluorescent coating on the inside of the bulb. As in the case of the earlier 80W and 125W "Osram" and "Mazda" lamps, this coating emits red light when subjected to ultra-violet radiation from the arc tube and compensates for the red deficiency in the arc. The average output throughout the life of the new lamps is given as 42 lumens per watt.

RULES FOR THE UNIT TESTING OF CIRCUIT BREAKERS FOR MAKING CAPACITY AND BREAKING CAPACITY.—Because of increases in voltage and circuit-breaking capacity requirements it has been found uneconomical to keep testing plant capacities abreast of those of circuit breakers. A solution of the problem is offered in a publication "Rules for the Unit Testing of Circuit Breakers for Making Capacity and Breaking Capacity" (A.S.T.A. No. 15), issued, price 10s., by the Association of Short Circuit Testing Authorities, 36, Kingsway, London, W.C.2. The rules are based on techniques developed mainly in ASTA testing stations. There is an appendix dealing with the important matter of the determination of the correct unit recovery voltage to be used on test.

CARTRIDGE TIMING OF STUD WELDING.—A new process of stud welding, in which the timing is carried out by means of a cartridge placed at the end of the stud, has been developed by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. In conventional welding practice the arc between stud and weld-piece is struck and timed by electronic and/or mechanical apparatus, and the studs have to be specially shaped and prepared. In the new process ignition and arc-time control are regulated by the cartridge itself. Normal studs, treated and untreated, including black studs, can be used. The stud welding gun contains a spring for pressing the stud holder against the weld-piece. It can be operated on a.c. mains and can be used with standard welding transformers.

SOFT-FACED HAMMERS.—The Thor Hammer Company, of Salop Street, Birmingham, 12, is now making a selection of soft-faced hammers in a number of different sizes and weights. These hammers are available with faces in copper, rawhide, cellulose, nylon, plastic material, and rubber, and the design is such that when the faces become worn and unserviceable they can easily be removed and replaced. Hammers in the larger sizes have hickory handles and in the smaller sizes ash handles. The hammer heads into which the faces are screwed or driven on pegs, according to the material, are made of malleable iron or steel. Where the cellulose or plastic hammers are required for particularly light work the heads are made of aluminium. For other industrial purposes the firm makes mallets with solid heads of rawhide, copper, plastic material, lead, nylon, lignum, &c.

BRITISH GAS TURBINE IN ITALY.—At the Third National Methane Exhibition, held at Piacenza, Italy, last month, the first industrial gas turbine to operate on Italian soil was demonstrated. The power unit displayed was a standard Ruston "TA" gas turbine, running on natural gas. The turbine demonstrated the economic utilisation of this fuel, now available in abundance in Northern Italy. The exhibit, and its simplicity of installation, attracted much attention and ease of control was demonstrated by inviting interested visitors to start and operate the unit after a few minutes' instruction. This particular unit was ordered by Societa Nazionale Metanodotti and was dispatched to its new power station at San Donato, near Milan, where it will supply lighting, power and heat for both industrial and domestic requirements.

BUILDING IN CONCRETE.—An exhibition of photographs showing the architectural development of concrete and its use in building and civil engineering is being held at the Royal Institute of British Architects, 66, Portland Place, London, W.1., from October 21st to 30th. The exhibition has been prepared by the joint committee on structural concrete representing the Cement and Concrete Association, the Prestressed Concrete Development Group and the Reinforced Concrete Association. As well as photographs from this country, a great deal of material has been collected from abroad and in particular there are a number of interesting photographs of Italian and Swiss buildings. Belgium, Denmark, Finland, France, Germany, and Holland have sent their contributions and there are also photographs from Australia, Brazil, India, Japan, and South Africa.

DRAGLINE EXCAVATORS.—We are informed by Jack Olding, Ltd., Hatfield, Herts, that the first three of twenty-five "Lima 1201" dragline excavators it is having built in this country have been completed and delivered to Sir Robert McAlpine and Sons, Ltd. The excavators, which are being built for Jack Olding, Ltd., by the North British Locomotive Company, Ltd., are of similar design and have all parts interchangeable with the American machines built by the Baldwin-Lima-Hamilton Corporation. The new machines are driven by Crossley four-cylinder diesel engines developing 240 b.h.p. at 875 r.p.m. and are fitted with a standard dragline boom, 80ft long, which can be reduced to 60ft by removal of a centre section. For dragline work a 3½ cubic yard bucket can be used, and when a machine is used with a face shovel it has a 32ft 6in boom, 22ft handle and uses a 3½ cubic yard bucket. Crane front and equipment can be fitted for use with booms from 60ft to 120ft long.

NEW TASKS FOR TELEFUNKEN.—In the course of further reorganisation, A.E.G. has decided to combine its interests in the fields of telecommunications at the company's subsidiary, Telefunken, which since 1941 has wholly belonged to A.E.G. Consequently on October 1st the A.E.G. telecommunications factory in Backnang and the Magnetophon-Gerätebau factory in Hamburg were transferred to Telefunken. Sales are handled as before by the sales organisations of both companies. The sphere of activities of Telefunken is substantially supplemented and increased by the taking over of fields which hitherto had been the concern of A.E.G., i.e. carrier frequency telephony, long-distance communications cables, power station telephony, duplex loud-speaker installations, telephone exchanges, and magnetic recording. Telefunken thereby deals with all aspects of telecommunications, by radio and by cable, for broadcasting, television, general transmission of information and direction finding, as well as valve manufacture, electro-acoustics and sound reproduction, including gramophone records.

MODULAR CO-ORDINATION IN BUILDING.—The final meeting of the European Productivity Agency's Modular Co-ordination Study Conference, which was held in London from October 11th to 15th, took place at the British Standards Institution last week. The delegates, who had come from Austria, Belgium, Denmark, France, Germany, Greece, Italy, Netherlands, Norway, Sweden, U.S.A., and the United Kingdom, agreed on the information to be included in the national reports for the first phase of this project. The reports, which are to be submitted to the E.P.A. by May next year, will deal with such aspects of the subjects as documentation, building products being made in the different countries, modular building systems in use, and related present and contemplated research programmes. A sub-committee has been set up to settle in the immediate future terms and definitions to facilitate international collaboration in modular co-ordination. During their week's stay the delegates to the Conference, who represented standards institutions, research organisations, Government departments, and universities, visited schools and housing projects in this country.

ROYAL MINT'S REPORT.—The annual report of the Deputy Master and Comptroller of the Royal Mint for the year 1952 has been published this week. It shows that during the year the Royal Mint struck 488,750,689 coins, of which 45,377,583 (9·3 per cent) were for the United Kingdom, 327,409,457 (67 per cent) were for other countries of the Commonwealth, and 115,963,649 (23·7 per cent) were for foreign governments. The report says that the year was outstanding for the extent of the export programme, for never before had so many coins been struck for overseas. The absence of home demand for additional cupro-nickel coins, and the suspension of the programme of exchanging cupro-nickel for silver coins enabled the Mint to devote much of its capacity to overseas coinages. Altogether seventy-seven denominations were struck for nineteen different countries abroad, the biggest customers being Australia, British East Africa, British West Africa, Bolivia, Burma, Libya, Malaya, New Zealand, and Southern Rhodesia. Bolivia was a new customer. There was a demand for United Kingdom halfpence and farthings, but the only United Kingdom cupro-nickel denomination asked for was the sixpence, which was needed in the West Indies. As a result the only cupro-nickel coins dated 1952 are about 1,000,000 coins of this denomination. The report describes the arrangements which were made by the Royal Mint Advisory Committee, under the presidency of H.R.H. The Duke of Edinburgh, to obtain designs for coins and medals current over about 13,000,000 square miles of the earth's surface and used by 100,000,000 of its population. Many reasons for and explanations of the characteristics of the new designs are given in the report.

Personal and Business

MR. A. J. BETTS has been appointed general sales manager of Enfield Cables, Ltd.

MR. W. E. WATSON has been appointed works director of Smiths Aircraft Instruments, Ltd.

LORD DERWENT has been elected chairman of the British Road Federation in succession to Lord Sandhurst.

THE ELECTRIC CONSTRUCTION COMPANY, Ltd., Wolverhampton, has established a factory at Duncanville, Vereeniging, South Africa.

RICHARD COSTAIN, Ltd., has now moved to new offices at 111, Westminster Bridge Road, London, S.E.1 (telephone, Waterloo 4977).

SIR MALCOLM TRUSTRAM EVE, G.B.E., Q.C., has been appointed to the board of Henry Simon (Holdings), Ltd., Cheadle Heath, Stockport.

THE MINISTER OF TRANSPORT AND CIVIL AVIATION announces the appointment of Mr. B. H. Harbour as a full-time member of the London Transport Executive.

MR. D. F. WALTON, local director of Thos. W. Ward, Ltd., Sheffield, has been appointed a director of the Ketton Portland Cement Company, Ltd., a subsidiary company.

FURNESS, WITHY AND CO., Ltd., announces that Captain James Baird has been appointed chief marine superintendent of the company in succession to Captain J. Isdale, D.Sc., who retired on September 30th.

KERRY'S (GREAT BRITAIN), Ltd., Warton Road, Stratford, London, E.15, has transferred its Ipswich branch to Russell Road, Ipswich (telephone, Ipswich 4382). Mr. R. W. Tuffs is the district manager.

MR. DONALD H. FINER has been appointed deputy chairman and joint managing director of Constructors, Ltd. Mr. J. A. Pinches has been appointed joint managing director, and Mr. A. E. Newland has succeeded Mr. Pinches as secretary of the company.

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, announces the following appointments:—Mr. G. R. Buckley, general works manager; Mr. E. Morgan, general manager in charge of research; Mr. L. Rawlins, commercial manager; and Mr. J. D. Hickman, export manager.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby, states that Mr. J. N. Griffiths is now attached to the Nottingham office at 71–73, Lower Parliament Street, Nottingham (telephone, Nottingham 43588). Mr. Griffiths, who handles electrical plant and apparatus business, has hitherto been attached to the Sheffield office.

THE WAR OFFICE announces the appointment of Professor S. J. Davies, D.Sc. (Eng.), M.I.Mech.E., as Dean of the Royal Military College of Science, Shrivenham. Professor Davies at present occupies the chair of mechanical engineering at King's College, University of London. He will retain that chair until the end of the present academic year.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces the following changes and appointments which are to take effect on December 1st. Mr. W. H. McFadzean, chairman and managing director; Mr. D. W. Aldridge, deputy chairman; Mr. H. J. Stone, general manager; Mr. W. C. Handley, deputy general manager; Dr. L. G. Brazier, director of research and education; and Mr. R. M. Fairfield, director of production and engineering. Mr. D. T. Hollingsworth is to become a director and will relinquish his position of chief engineer in order to take up an appointment with an associated company.

Contracts

THE BRITISH ELECTRICITY AUTHORITY has placed contracts during the past month for power stations and transmission lines amounting in the aggregate to £2,888,084. The principal contracts include:—Belvedere power station, Kent, preliminary access works (John Laing and Son, Ltd.); Brighton "B" power station, sewer under Shoreham Harbour (Charles Brand and Son, Ltd.) and coal-handling plant (Mitchell Engineering, Ltd.); Littlebrook "C" power station, Dartford, one 360,000 lb per hour boiler (International Combustion, Ltd.); Willington "A" power station, near Derby, instruments and automatic controls (Electroflo Meters, Ltd.); Elland power station, Yorks, structural steelwork for boiler-house and turbine-house (Heenan, Beddow and Sturmey, Ltd.); Skelton Grange power station, Leeds, No. 3 cooling tower (Film Cooling Towers (1925), Ltd.); Wakefield "B" power station, Yorks, 11kV and low-voltage main and auxiliary cables (Drake and Gorham (Contractors), Ltd.); Stella North power station, Newcastle upon Tyne, main and auxiliary cables and accessories (London Electricity Board); Barony power station, Ayr, 33kV switchgear and accessories (Cooke and Ferguson, Ltd.); and Uskmouth-Melksham, 275kV twin 0·175 square inch double circuit line (J. L. Eve Construction Company, Ltd.).

British Patent Specifications

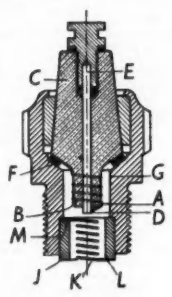
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

715,720. August 27, 1952.—GLOW PLUGS, Societe Nouvelle des Isolants and Bougies Pognon, 1, rue de la Cité, Clermont-Ferrand, Puy-de-Dôme, France.

According to the invention, a glow plug comprises a hollow plug body containing a filament fed with a low-voltage electric current, and an igniter coil to effect ignition due to the temperature it attains as a result of the engine operation, the igniter coil being mounted in a socket fitted within the extremity of the bore of the plug body. In the drawing, the usual filament *A* is shown wound on an extension *B* of the insulating body *C* of the glow plug and is connected at one end *D* to the central current-conveying pin *E* and at its other end to the conducting packing ring *F*. In the lower bore *G* of the plug body there is fixed a socket *J*. The socket contains an igniter coil *K* consisting of a spirally wound wire, the two extremities *L* and *M* of which are fixed to the socket *J* by welding. The length, section and composition of the coil *K* are naturally determined in dependence on the working conditions and the compression ratio of the engine to which the glow plug is to be applied. The mounting of the igniter coil *K* by means of a separate socket makes it possible, by suitably positioning the socket within the bore of the plug body and suitably choosing the length of the socket, to cause the coil to penetrate the cylinder more or less deeply in order to place it at the point of the combustion chamber where, taking into account the turbulence in the engine, the ignition takes place under the best conditions. It is also possible to choose the shape and the dimensions of the inner bore of the socket *J*, which provides around the coil *K* a kind of chamber which becomes filled with burning gases, so as to utilise the heating power to the best advantage.—*September* 22, 1954.

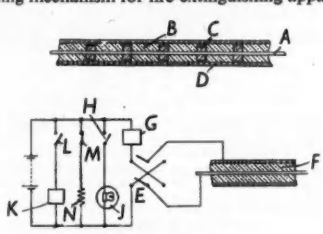


No. 715,720

TESTING INSTRUMENTS AND APPARATUS

715,317. August 24, 1950.—FIRE AND HEAT DETECTORS, National Research Development Corporation, 1, Tilney Street, London, W.1. (*Inventors: Henry Warburton Hall, Robert Noel Claude Strain, and Isaac Alan Mossop.*)

The invention relates to fire and heat detectors in which the detector element consists of two electrical conductors spaced apart by a substance which will, relatively speaking, conduct electricity to a useful extent only when it is raised to a predetermined temperature, the conductors being connected in circuit with an electrical indicating instrument or actuating mechanism for fire-extinguishing apparatus.



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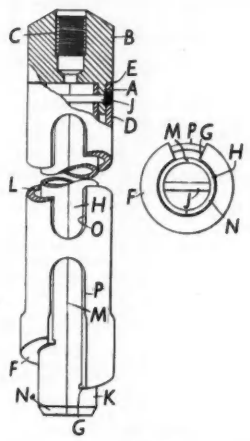
As shown in the upper view of the drawing, an element comprises a wire *A* of metal of a kind to which glass may be readily bonded, such as a nickel-chromium alloy, on to which are threaded short lengths of glass capillary tubing *B* alternate with heat-resisting quartz spacers *C*. Inserted in a metal tube *D* a detector element constructed in this way may be bent through quite sharp turns. The circuit arrangement comprises a reversing switch *E* interposed between a battery and a detector element *F* and a relay *G*, which, when energised by current through the element *F* closes contact *H* and so lights a warning lamp *J*. The circuit also includes a further relay *K* for actuating the reversing switch *E* and which is controlled by a bi-metallic strip operated switch having contacts *L* and *M* and of which the heater is indicated at *N*. In operation, when the battery is connected and the heater *N* is cold, current flows through the normally closed contacts *M* and the heater. When a predetermined temperature is reached the contacts *M* open and the normally open contacts *L* close thereby energising the relay *K* and operating the reversing switch *E*. When the temperature has in consequence fallen again, the contacts *M* close and the contacts *L* open, so de-energising the relay *K*, whereupon the reversing switch returns to its initial position. The main relay *M*, which is operated by the detector *F* to switch on the warning device *J*, is made sufficiently sluggish not to open during the reversals of the supply connections. An alternative circuit arrangement is also shown in the specification.—*September* 15, 1954.

MINING ENGINEERING

715,901. December 3, 1951.—CORE DRILLS, Frank Walmsley, Reginald Henry Procter, and English Drilling Equipment Company, Ltd., all of the company's address at Bilbao House, 36–38, New Broad Street, London, E.C.2.

In the drawings, as shown, an auger drill is mounted at its upper end upon an axial extension *A* of a head *B* which is threaded at *C* to connect it to a drill rod. The auger drill *D* fits the head extension and is welded to the head at *E*. At its lower end the auger drill is provided with one or more helical or inclined surfaces



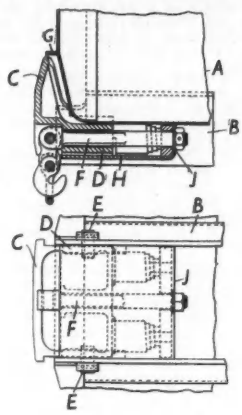
No. 715,901

F and at the leading end of each helical surface a cutting edge *G* is provided. Located within the auger drill is a core barrel *H*, its upper end fitting within the head extension *A* and being screwed to it. A transverse locking pin *J* extends through the auger drill, the head extension and the core barrel and has a threaded end which screws into a tapped hole in the head. The lower end *K* of the core barrel *H* projects beyond the auger helical or inclined surface *F*, so that it receives the core or sample at an undisturbed part of the soil formation. The helical or inclined terminating surface *F* of the auger extends radially inwardly to engage the surface of the core barrel. Thus there will be a space *L* between the auger barrel and the core barrel into which the cuttings or spoil will be forced by the action of the auger. Thus, the core and the spoil or cuttings will be removed in the one and same drilling operation. The core barrel *H* is preferably split longitudinally at *M* to facilitate removal of the core. At the lower end the core barrel is provided with a bevelled cutting edge *N*. One or more openings *O* may be provided above the lower axial opening *P* of the auger barrel to facilitate removal of the packed spoil when removing the core barrel. By locating the operative end *K* of the core barrel in advance of the auger drill, an undisturbed core will be ensured, and further when working in a hole filling with water from a higher level it will aid in keeping the core as dry as possible. The lower drilling end of the auger drill is somewhat larger in diameter than the upper part giving suitable clearance for repeated operations without using additional reaming tools.—*September* 22, 1954.

RAILWAY ENGINEERING

715,782. April 16, 1952.—SPRING BUFFER FOR RAILWAY VEHICLES, Gutehoffnungshutte Oberhausen Aktiengesellschaft, of Oberhausen (22a), Germany.

The invention relates to a spring buffer for railway vehicles, more particularly for goods wagons. Referring to the drawings, *A* is the body of the goods wagon, which rests on the supporting frame *B*. The buffer plate *C* with its guiding parts *D* forms part of a box-like buffer body, which is slidable longitudinally in the supporting frame and the movement of which is limited by the bolts *E*, which engage in longitudinal slots in the parts *D*. The drawbar *F* is mounted centrally in the buffer body but is not secured to it. Consequently, the buffer reacts only to pressure and is not influenced by pull. A protecting frame *G* secured to the body above the front buffer plate *C*, prevents foreign matter from dropping behind the buffer plate. As a protection against dirt, the buffer body and the drawbar are covered underneath by a protecting plate. The protecting plate *H* forms the rear wall of the draw and plunger device so that the drawbar *F* can be secured in this rear wall



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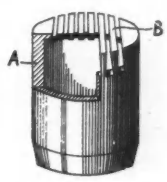
J. The buffer body forms a box-like block which is held at both sides by short bolts so that the disadvantages which arise by the breaking of the plungers are avoided. Owing to its block formation and its simple form of attachment to the supporting frame, the buffer is especially suitable to be incorporated easily and rapidly in any existing goods wagons.—*September* 22, 1954.

METALLURGY

715,710. May 8, 1952.—VENT PLUG FOR FOUNDRY USE, Hermann Willy Krauss, Dietfurt/Altmühl, Germany.

The invention relates to a vent for sand blowing in core boxes and cast iron moulds. As will be seen from the drawing, the vent plug which is embedded in any casting box consists of the cylindrical part *A*, one end of which is covered with grate bars *B*. The gaps between the bars are so formed that the section of the passage is tapered, widening towards the outside whilst the inlet end is narrowed down. In this way the gaps allow the air coming from the core box to flow out whilst the bars *B* catch the sand that is dragged along and do not permit it to be deposited on the surfaces which are widened towards the outside since owing to the narrowed inlet opening, they are not reached by the impacting current of sand and air. Two types of bevelled bars are shown in the specification.—*September* 22, 1954.

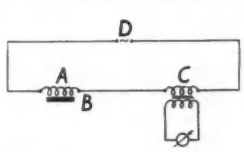


No. 715,710

ELECTRICAL ENGINEERING

716,018. November 27, 1952.—APPARATUS FOR TESTING THE MAGNETIC PROPERTIES OF FERROUS MAGNETIC MATERIAL, Siemens and Halske Aktiengesellschaft, Siemensstadt, Berlin, and Wittelsbacher Platz, 4 Munich 2, Germany.

The invention is particularly concerned with the testing of such material in the form of laminations or sheet metal rings. One arrangement of apparatus according to the invention is shown in the drawing



No. 716,018

diagrammatically. It comprises a large choke coil *A* having a core consisting of a large number of laminations *B*, the coil being connected in series with a small test transformer *C*. An alternating voltage is applied to the series arrangement from a source *D*. Owing to the large iron core of the coil *A*, the major portion of the sinusoidal voltage is developed across the coil. Thus, this coil *A* causes a current to flow which produces a sinusoidal flux density in the associated iron core *B*. The same current also flows in the primary winding of the test transformer *C* and thus also produces a sinusoidally varying flux density in the material under test. The choke coil *A* can, of course, be replaced by a transformer having a large iron core.—*September* 22, 1954.

Launches and Trial Trips

ESSO YORK, oil tanker; built at the Walker yard of Vickers-Armstrongs, Ltd., for the Esso Petroleum Company, Ltd.; length overall 628ft, length between perpendiculars 600ft, breadth moulded 82ft 6in, depth moulded 42ft 6in, deadweight 26,650 tons; thirty cargo oil tanks, one cargo oil pump room, four cargo oil pumps and one stripping pump; one set of geared turbines, 13,750 s.h.p. at 115 r.p.m. of propeller, two Babcock and Wilcox boilers.—Launch, September 27th.

BELFAST, oil tanker; built at Govan by Harland and Wolff, Ltd., for Belships Company, Ltd., Skibs A/S; length between perpendiculars 540ft, breadth moulded 73ft, depth moulded 39ft 3in, deadweight 18,500 tons; twenty-seven cargo oil tanks, two cargo oil pump rooms, four 500 tons per hour cargo oil pumps, two 75kW steam-driven generators, one 75kW diesel-driven generator; Harland and Wolff-B. and W. two-cycle, single-acting, opposed piston oil engine, six cylinders, 750mm diameter by 2000mm combined stroke, 114 r.p.m., two cylindrical multitubular boilers. Launch, September 28th.

CAPETAN CARRAS, cargo liner; built at the Neptune Works of Swan, Hunter and Wigham Richardson, Ltd., for the Tramp Chartering Corporation of Panama; length between perpendiculars 450ft, breadth moulded 62ft, depth moulded to shelter deck 40ft 4in, five holds, ten 10-ton, one 20-ton and one 30-ton derricks, electric deck machinery; three 180kW diesel-driven generators, one 50kW diesel-driven generator; Swan Hunter-Doxford oil engine, five cylinders, 670mm diameter by 2320mm combined stroke, 5500 b.h.p. at 115 r.p.m. Launch, September 28th.

CEDARBANK, cargo liner; built at Belfast by Harland and Wolff, Ltd., for the Andrew Weir Shipping and Trading Company, Ltd.; length overall 450ft, length between perpendiculars 425ft, breadth moulded 59ft, depth moulded to shelter deck 38ft 3in, gross tonnage 5800; two steel decks, seven watertight bulkheads, four main cargo holds, two 3-ton, fourteen 5-ton and one 25-ton derricks, electric deck machinery, three 175kW diesel-driven generators; Harland-B. and W. two-stroke, single-acting, opposed piston diesel engine, six cylinders, 620mm diameter by 1870mm combined stroke, two vertical boilers. Launch, September 29th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Thurs., Nov. 4th.—SCOTTISH SECTION: Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, "Latest Developments in T.V. Cameras," H. McGhee, 7 p.m.——MERSEYSIDE SECTION: College of Technology, Byron Street, Liverpool, 3, "Radio Receiving Valve Manufacture," G. P. Thwaites, 7 p.m.——NORTH-WESTERN SECTION: Reynolds Hall, College of Technology, Sackville Street, Manchester, "Electronic Servo Mechanisms," J. L. Russell, 7 p.m.

CHEMICAL SOCIETY

Thurs., Nov. 4th.—Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7, "Open and Closed Sequences in Reaction Kinetics," J. A. Christiansen, 7.30 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Tues., Oct. 26th.—Church Institute, Hull, "Planned Maintenance," W. Jones, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

To-day, Oct. 22nd.—BATH AND BRISTOL CENTRE: Royal Hotel, Bristol, "An Analytical Approach to Industrial Lighting," W. Imrie Smith, 6.15 p.m.

Mon., Oct. 25th.—LEEDS CENTRE: E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds, 1, Chairman's Address, J. R. Bardsley; Presidential Address, E. C. Lennox, 6.15 p.m.——LEICESTER CENTRE: Demonstration Theatre, E. Midlands Electricity Board, Charles Street, Leicester, "Artificial Illumination of Horticultural Crops," A. Calvert, 6 p.m.

Fri., Oct. 29th.—BIRMINGHAM CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "Teaching Illuminating Engineering," 6.30 p.m.

Tues., Nov. 9th.—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "Shop Lighting," R. L. C. Tate, 6 p.m.

INCORPORATED PLANT ENGINEERS

Tues., Oct. 26th.—SOUTHAMPTON BRANCH: Evening Visit (with special reference to costing) to Folland Aircraft, Ltd., Hamble, 5.30 p.m.——W. AND E. YORKS BRANCH: The University, Leeds, "Heatless Repair of Broken Castings," 7.30 p.m.

Thurs., Oct. 28th.—SHEFFIELD AND DISTRICT BRANCH: Grand Hotel, Sheffield, "Boiler Feed Water Treatment for Industrial Problems," C. J. Carter, 7.30 p.m.

Fri., Oct. 29th.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, Films, "Oil in Industry," "Liquid Fuel in Industry," "Grease," "Project 074," followed by discussion, 7.30 p.m.

Tues., Nov. 2nd.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, Strand, London, W.C.2, "The Science of Applied Chromatics," E. M. Barford, 7 p.m.

Wed., Nov. 3rd.—SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, "Steam Costs," E. C. Rogers, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., Nov. 9th.—SLOUGH SECTION: Lecture Theatre, High Duty Alloys, Ltd., Slough, Bucks, "Propeller Manufacture," J. M. Langham, 7.30 p.m.

INSTITUTE OF FUEL

Wed., Oct. 27th.—NORTH-WESTERN SECTION: The Engineers' Club, Albert Square, Manchester, "An Account of American Fuel Research and the Work of the New Fuel Efficiency Service," W. A. Macfarlane, 2.15 p.m.

Thurs., Oct. 28th.—MERSEYSIDE SUB-SECTION: Liverpool Engineering Society's Rooms, 9, The Temple, Dale Street, Liverpool, "Shell Boilers," A. D. C. Gunn, 7 p.m.

Mon., Nov. 1st.—SCOTTISH SECTION: Royal Technical College, Glasgow, "The Constitution of Coal Tar," D. McNeil, 7 p.m.

INSTITUTE OF INDUSTRIAL SUPERVISORS

Wed., Oct. 27th.—LEICESTER SECTION: Partridge Wilson Company, Ltd., Evington Valley Road, Leicester, "Meeting Competition by Reducing Manufacturing Costs," Sir Anthony Bowlby, 7.30 p.m.

Tues., Nov. 2nd.—LONDON CENTRAL SECTION: Waldorf Hotel, Aldwych, London, W.C.2, Joint Meeting with Institution of Works Managers, 7.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Fri., Oct. 29th.—MERSEYSIDE AND NORTH-WESTERN SECTION: Old Swan Technical College, Liverpool, "Marine Diesel Engines," A. G. Arnold, 7 p.m.

INSTITUTE OF METALS

Tues., Nov. 2nd.—OXFORD LOCAL SECTION: Cadena Café, Cornmarket Street, Oxford, "Ceramics," J. White, 7 p.m.

Thurs., Nov. 4th.—LONDON LOCAL SECTION: Royal School of Mines, South Kensington, London, S.W.7, "Trends in Metallurgy," A. G. Quarrell, 7 p.m.

INSTITUTE OF PETROLEUM

Mon., Oct. 25th.—STANLOW BRANCH: Grosvenor Hotel, Chester, "In the Modern Oil Industry," Gustav Egloff, 7.30 p.m.

Thurs. and Fri., Oct. 28th and 29th.—Institution of Electrical Engineers, Savoy Place, London, W.C.2, Conference on "Molecular Spectroscopy," organised by Spectroscopic Panel of the Hydrocarbon Research Group.

INSTITUTE OF PHYSICS

Fri., Oct. 29th.—47, Belgrave Square, London, S.W.1, Discussion Group led by W. G. Cook on "Jet Engines and Non-Destructive Testing," 6.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Tues., Oct. 26th.—N. EASTERN GROUP: Royal County Hotel, Durham, "Protective Finishes for Road Vehicles," W. T. Watson, 7 p.m.

INSTITUTE OF WELDING

Tues., Nov. 9th.—LIVERPOOL AND DISTRICT BRANCH: Liverpool College of Technology, Byron Street, Liverpool, "Make Do and Mend Repairs," G. G. Musted, 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Oct. 26th.—MARITIME MEETING: Great George Street, Westminster, London, S.W.1, "The Queen Elizabeth II Dock," D. C. Milne, 5.30 p.m.

Fri., Oct. 29th.—SCUNTHORPE BRANCH: Blue Bell Hotel, Scunthorpe, "The Design and Construction of the Handling and Treatment System for Liquid Radio-Active Wastes," W. L. Wilson, and "Operational Experiences with a Handling and Treatment System for Liquid Radio-Active Wastes," R. H. Burns, 6.30 p.m.

Tues., Nov. 2nd.—ORDINARY MEETING: Great George Street, Westminster, London, S.W.1, Presidential Address by D. M. Watson, 5.30 p.m.

Mon., Nov. 8th.—LEEDS BRANCH: General Lecture Theatre, Leeds, "Owen Falls, Uganda, Hydro-Electric Development," Sir Charles Westlake, T. A. L. Paton and R. W. Mountain, 7 p.m.

Wed., Nov. 10th.—HULL BRANCH: Electricity Showrooms, Lecture Theatre, Ferensway, Hull, "Construction of Queen, Elizabeth II Dock," D. C. Milne, 6.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Oct. 25th.—RADIO SECTION: Savoy Place, London, W.C.2, Discussion on "Whether Compatibility is Necessary for a Colour Television System in Great Britain," opened by E. P. Wethey, 5.30 p.m.

Tues., Oct. 26th.—LONDON STUDENTS' SECTION: R.E.M.E. Training Centre, Hazebrouck Barracks, Arborfield, Berks, Chairman's Address, "The History of the Institution," M. C. Cubitt, 7 p.m.

Wed., Oct. 27th.—SUPPLY SECTION: Savoy Place, London, W.C.2, Chairman's Address, J. D. Peattie, 5.30 p.m.

Mon., Nov. 1st.—LONDON STUDENTS' SECTION: Savoy Place, London, W.C.2, "Pumped Storage for Peak Load Power Supplies," C. D. Gardiner, 7 p.m.

Tues., Nov. 2nd.—MEASUREMENTS SECTION: Savoy Place, London, W.C.2, Discussion on "Boreholes: Instrumentation for Measurements at Depth," P. Threadgold, 5.30 p.m.——NORTH MIDLAND CENTRE: British Electricity Authority, 1, Whitehall Road, Leeds, 1, "Technical Arrangement for the Sound and Television Broadcast of the Coronation Ceremonies on 2nd June, 1953," W. S. Proctor, M. J. L. Pulling and F. Williams, 6.30 p.m.——S.E. SCOTLAND SUB-CENTRE, CENTRE MEETING: Carlton Hotel, North Bridge, Edinburgh, "The Possibilities of a Cross-Channel Power Link," D. P. Sayers, M. E. Laborde, F. J. Lane, 7 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., Nov. 1st.—NORTH-EAST BRANCH: Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, "Research and the Designer," A. F. B. Young, 7.15 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 2nd.—39, Elmbank Crescent, Glasgow, "Resistance and Propulsion of Single-Screw Coasters, Part II, L/B-6," J. Dawson, 7.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Wed., Nov. 17th.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, "A Modern Hydraulic Drive for Locomotives," R. H. Fett, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 22nd.—GENERAL MEETING, HYDRAULICS GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, "Modern Development in the Use of Large Single-Entry Centrifugal Pumps," H. H. Anderson, 5.30 p.m.

Mon., Oct. 25th.—SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Engine Research and Development as a Service to Industry: A Personal Experience," J. H. Pitchford, 7.30 p.m.

Tues., Oct. 26th.—SOUTH WALES BRANCH: Park Place, Cardiff, "High-Temperature Cooling of Open-Hearth Furnaces by Means of Steam-Producing Elements," P. M. Moreton, and "The Efficient Production and Utilisation of Steam in Steelworks," F. J. Feltoe, 6 p.m.

Wed., Oct. 27th.—SOUTHERN GRADUATES' SECTION: Guildford Technical College, Guildford, "An Introduction to the Preparing of Contract Specifications for Mechanical Plant," P. D. Pepe, 7 p.m.——EDUCATION GROUP: 1, Birdcage Walk, Westminster, London, S.W.1, Discussion, "Units of Measurement of Length, Mass and Force Employed in the Teaching of Applied Mechanics and General Mechanical Engineering Subjects," 6.45 p.m.

Thurs., Oct. 28th.—WESTERN A.D. CENTRE: Royal Hotel, Bristol, Address by the A.D. Chairman-Elect, J. H. Pitchford, "Engine Research and Development as a Service to Industry: A Personal Experience," 6.45 p.m.

Fri., Oct. 29th.—GENERAL MEETING: 1, Birdcage Walk, Westminster, London, S.W.1, Parsons Memorial Lecture, "Factors Influencing the Continuing Development of the Gas Turbine," F. Dollin, 5.30 p.m.

Mon., Nov. 8th.—SCOTTISH GRADUATES' SECTION: Royal Technical College, Glasgow, Film Evening, 7.30 p.m.

Wed., Nov. 17th.—SOUTHERN BRANCH: Brighton Technical College, Brighton, Sussex, "The Future of the C.I. Engine in Small Road Vehicles," J. H. Pitchford, 7 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., Oct. 27th.—INFORMAL MEETING: Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1, Vice-Chairman's Address, "Is Your Stores Problem Really Necessary?" F. C. G. Greening, 5 p.m.

Tues., Nov. 9th.—The Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Future Demands for Telephone Service: Possible Trends and Reactions," J. M. Norman, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Oct. 25th.—SHEFFIELD GRADUATE SECTION: The Royal Victoria Station Hotel, Sheffield, "Shell Moulding," D. N. Buttrey.

Tues., Oct. 26th.—LUTON SECTION: Small Assembly Room, Town Hall, Luton, "High Permeability Steel Castings for the Electrical Industry," J. F. Hinsley, 7.15 p.m.

Wed., Oct. 27th.—DUNDEE SECTION: School of Economics, Dundee, "The Motion Study Aspect of Work Study," Miss Anne Shaw, 7.30 p.m.——SHREWSBURY SECTION: The Oakengates Technical College, Oakengates, "Colour as an Aid to Production," Miss Raine, 7.30 p.m.

Thurs., Oct. 28th.—SOUTH WALES AND MONMOUTHSHIRE SECTION: South Wales Institute of Engineers, Park Place, Cardiff, "High-Speed Presswork," J. A. Grainger, 7 p.m.

Sat., Oct. 30th.—LINCOLN SECTION: The Ruston Club, Unity Square, Lincoln, "How the Production Engineer can be Helped by the Metallurgist," J. D. Jevons, 7.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Oct. 22nd.—MIDLAND COUNTIES BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Chairman's Address, W. Phillips, 6 p.m.

Mon., Oct. 25th.—SCOTTISH BRANCH: Cadoro Restaurant, Union Street, Glasgow, Chairman's Address, W. Heigh, 6 p.m.

Tues., Oct. 26th.—SCOTTISH BRANCH: Grosvenor Restaurant, Gordon Street, Glasgow, Annual Dinner and Dance.

Thurs., Oct. 28th.—11, Upper Belgrave Street, London, S.W.1, "Foundations Underpinning and Structural Problems at the Daily News Building in the City of London," F. W. Slater and A. Brown, 5.55 p.m.

Tues., Nov. 2nd.—NORTHERN IRELAND BRANCH: Grand Central Hotel, Belfast, Annual Dinner and Social Function, 6.30 p.m.

Thurs., Nov. 4th.—MIDLAND COUNTIES BRANCH: Public Library, Stafford, "Examples of Site Exploration," E. Morton, 7 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Oct. 25th.—MANCHESTER SECTION: Engineers' Club, Albert Square, Manchester, "Purchasing and Stores Control of Raw Materials Used in the Insulated Wire and Cable Industry," C. W. Kelsey, 6.15 p.m.

Wed., Oct. 27th.—LEICESTER SECTION: Bell Hotel, Leicester, "Microcellular Soling," W. R. Pryer, 7.30 p.m.

IRON AND STEEL INSTITUTE

Wed. and Thurs., Nov. 17th and 18th.—4, Grosvenor Gardens, London, S.W.1, Autumn General Meeting and Joint Meeting with French and British Forgemasters.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 22nd.—INFORMAL MEETING: Pepys House, 14, Rochester Row, London, S.W.1, "The Manufacture of Portland Cement," W. C. Fliiton, 7 p.m.

Fri., Oct. 29th.—INFORMAL MEETING: Pepys House, 14, Rochester Row, London, S.W.1, "Some Notes on the Static Compressive Strength of Wool Felt, with Reference to the Isolation of Shock," followed by "Some Notes on the Dynamic Characteristics of Wool Felt," R. J. Herbert, 7 p.m.

Wed., Nov. 3rd.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "The Modern Tendency of Railway Signalling Practice," W. J. Sadler, 7 p.m.

Fri., Nov. 5th.—Pepys House, 14, Rochester Row, London, S.W.1, Film Evening, E. A. Applebee, 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., Nov. 18th.—Liverpool Engineering Society, The Temple, Dale Street, Liverpool, "The Fracture of Metals," C. E. Phillips, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Oct. 29th.—Engineers' Club, Albert Square, Manchester, "Testing Lubricants for the Prevention or Promotion of Wear," T. B. Lane, 6.45 p.m.

Fri., Nov. 12th.—Engineers' Club, Albert Square, Manchester, 2, "A Brief Survey of the Early History of Woolwich Arsenal," O. F. G. Hogg, 6.45 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Oct. 29th.—Mining Institute, Newcastle upon Tyne, "Ship Structural Members: Part VI," J. McCullum, 6.15 p.m.

Fri., Nov. 12th.—Mining Institute, Newcastle upon Tyne, "Instrumentation in Engineering Research with Particular Reference to Marine Turbine Machinery," B. J. Terrell, 6.15 p.m.

ROYAL STATISTICAL SOCIETY

Tues., Oct. 26th.—Westminster Medical School, Horseferry Road, London, S.W.1, Study Circle on Medical Statistics, 6 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Tues., Nov. 16th.—B.I.S.R.A., Hoyle Street, Sheffield, "Specifications: Friends or Foes?" S. Barraclough, 7 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues., Nov. 9th.—Geological Society, Burlington House, London, W.1, "The Decoloration of Sugar Liquor by Solid Absorbents," H. C. S. de Whalley, 5.30 p.m.

Thurs., Nov. 18th.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "The Constitution and Structure of Coal Tar Pitch," L. J. Wood, 6 p.m.

TIMBER DEVELOPMENT ASSOCIATION, LTD

Mon., Oct. 25th.—Manchester College of Commerce, Whtworth Street, Manchester, "Mechanical Handling of Timber," G. A. B. Storey, 7 p.m.

Wed., Oct. 27th.—Brixton School of Building, Brixton, London, S.W.9, "Grading of Timber," F. D. Silvester, 6.45 p.m.——S.E. London Technical College, Lewisham, S.E.6, "To-day's Timbers," C. H. Gobie, 7 p.m.

WOMEN'S ENGINEERING SOCIETY

Mon., Oct. 25th.—LONDON BRANCH: 35, Grosvenor Place, London, S.W.1, "The Metal Spraying Process," J. A. Shepherd, 7 p.m.

Thurs., Nov. 4th.—MANCHESTER BRANCH: Visit to the British Oxygen Company, Ltd., 6.45 p.m.